ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY W. H. MAW AND ALEX. RICHARDSON.

VOL. CX.—FROM JULY TO DECEMBER, 1920.

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1920.

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OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2

VOL. CX.—No. 2844.] *LONDON: FRIDAY, JULY 2, 1920.* [*Registered at the General Post Office as a Newspaper.*] PRICE... 1s. 2d. BY FOREIGN POST ... 1s. 5d.

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See Full Page Advt., page 72, June 25.

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See Full Page Advertisement, June 25.

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LONDON COUNTY COUNCIL.

The London County Council

Invites Engineers and Others

possessing the requisite technical knowledge to SUBMIT DESIGNS for a new type of ELECTRIC TRAMCAR for use on its tramways.

The competition will be open to persons of any nationality, and whether resident in Great Britain or not. No person in the service of the Council will be eligible to compete.

The designs will be assessed by Mr. A. L. C. FELL, General Manager of the Council's tramways, and an engineer nominated by the President of the Institution of Civil Engineers.

The conditions of competition provide for the award of a prize of £1000 to the competitor who sends in the design which it is decided by the assessors is the best of those submitted and which complies with such conditions.

The designs accompanied by the necessary reports, specifications, etc., must be delivered at the competitor's own expense not earlier than 1st November and not later than 4 p.m. on Tuesday, 30th November, 1920. Applications for conditions, plans, etc., relating to the competition should be addressed to the General Manager, London County Council Tramways, No. 23, Belvedere Road, London, S.E. 1.

Competitors, on payment of a sum of two guineas, will be furnished with a general drawing of the type of car at present in general use on the London tramways system, accompanied by the more important particulars relating thereto. This amount will be returned to each competitor who submits a bona fide design and does not subsequently withdraw the same, and also any person who, on receipt of the conditions, etc., decides not to compete and returns the copy of the drawing, etc., referred to above, within two weeks.

JAMES BIRD,
Clerk to the London County Council.
H 419

Glamorgan County Council.

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This Summer School will be held from July 26th to August 14th at the University College, Cardiff, and the Boys' County School, Penarth. Courses being provided as follows:—

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SESSION 1919-20.

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TENDERS.

RHYMNEY VALLEY URBAN DISTRICT COUNCIL.

PIPELAYING.

The Urban District Council of Rhymney Vale are prepared to receive

Tenders for the Laying of

certain CAST-IRON PIPES (principally 9 inch) and ancillary works in the Parish of Rhymney Vale for a distance of about three miles.

Drawings may be seen and Specifications and Schedules of Quantities obtained on and after the 26th June, 1920, on application to the office of the Engineers, SIR ALEX. BINNIE SON & DEACON, 30, Buckingham Gate, Westminster, S.W. 1, or at my office in Rhymney Vale, on deposit of a cheque for £2 2s. made out to me, which will be returned on receipt of a bona fide tender.

Sealed Tenders endorsed "Tender for laying Cast-iron Pipes, etc." are to be delivered at my office before noon on Friday, the 16th July, 1920. Tenders will only be accepted from persons with pipe laying experience.

The Council do not bind themselves to accept the lowest or any Tender, or to defray any expenses in connection with tendering.

Dated this 25th day of June, 1920.

THO. HUGHES,
Clerk to the Council.

District Council Office,
Rhymney Vale. H 388

RHYMNEY VALLEY URBAN DISTRICT COUNCIL.

SLUICE VALVES, &c.

The Urban District Council of Rhymney Vale are prepared to receive

Tenders for the Supply and

DELIVERY of SIX SLUICE VALVES of 9 in. and smaller sizes, together with AIR VALVES and SURFACE BOXES.

Specifications and Schedules of Quantities may be obtained on and after the 25th June, 1920, on applications to the office of the Engineers, SIR ALEX. BINNIE SON & DEACON, 30, Buckingham Gate, Westminster, S.W. 1, on deposit of a cheque for £2 2s. made out to me, which will be returned on receipt of a bona fide Tender.

Sealed Tenders endorsed "Tender for Valves, &c.," are to be delivered at my office before noon, on Friday, the 16th July, 1920.

The Council do not bind themselves to accept the lowest or any Tender, or to defray any expenses in connection with tendering.

Dated this 25th day of June, 1920.

THO. HUGHES,
Clerk to the Council.

District Council Offices,
Rhymney Vale. H 389

RHYMNEY VALLEY URBAN DISTRICT COUNCIL.

CAST IRON PIPES, &c.

The Urban District Council of Rhymney Vale are prepared to receive

Tenders for the Supply and

DELIVERY of about 480 tons of CAST IRON PIPES (principally 9 inch).

Specifications and Schedules of Quantities may be obtained on and after the 25th June, 1920, on application to the office of the Engineers, SIR ALEX. BINNIE SON & DEACON, 30, Buckingham Gate, Westminster, S.W. 1, on deposit of a cheque for £2 2s. made out to me, which will be returned on receipt of a bona fide Tender.

Sealed Tenders endorsed "Tender for Cast Iron Pipes" are to be delivered at my office before noon on Friday, the 16th July, 1920.

The Council do not bind themselves to accept the lowest or any Tender, or to defray any expenses in connection with tendering.

Dated this 25th day of June, 1920.

THO. HUGHES,
Clerk to the Council.

District Council Offices,
Rhymney Vale. H 390

BOROUGH OF POOLE.

POOLE WATERWORKS.

Contract No. 2.

Tenders for the Supply and

ERECTION of PUMPING MACHINERY.

The Corporation of Poole invite Tenders for the manufacture, delivery, erection, setting to work and testing of one triple expansion Pumping Engine with borehole and ram pumps, together with boiler plant, and other machinery complete.

The plant is to be erected at the Corporation Pumping Station, Corfe Mullen, Dorset.

Specification, Forms of Tender, Drawings, etc., may be seen at the Offices of the Engineer, Mr. A. P. I. Cotterell, M.Inst.C.E., 17, Old Queen St., Westminster, S.W. 1, on or after the 6th day of July next during the usual office hours.

Contractors wishing to tender may obtain copies of the Specification, Form of Tender, Drawings, etc., from the Engineer on payment of the sum of £5 5s., which will be returned on receipt of a bona fide Tender.

Tenders enclosed in sealed envelopes, addressed to the undersigned, and endorsed "Pumping Machinery," must be delivered not later than 10 a.m. on the 3rd day of August next.

The Corporation do not bind themselves to accept the lowest or any Tender.

By Order,
CHARLES LISBY,
Town Clerk.

Municipal Buildings,
Poole, Dorset. H 487

SOUTH STAFFORDSHIRE WATERWORKS COMPANY.

The CHAIRMAN and DIRECTORS invite

Tenders from Engineering

Firms for SUPPLYING and Erecting a TURBINE PUMP and MOTOR, capable of pumping 20,000 gallons per hour against a total head of 480 ft. including friction and suction.

Forms of Tender, Copies of Conditions, Specification and Plans, may be obtained from the undersigned.

The lowest or any Tender will not necessarily be accepted.

FRED. J. DIXON, M.INST.C.E.,
Engineer.

28th June, 1920.
26a, Paradise Street,
Birmingham. H 493

COUNTY BOROUGH OF GRIMSBY.

ELECTRICITY DEPARTMENT.

The CORPORATION are prepared to receive

Tenders for the Following:—

SPECIFICATION No. 145, BOILER HOUSE PLANT. The Specification comprises two Water-tube Boilers, together with Economisers, fittings, fans, Chimney, etc.

SPECIFICATION No. 147, 3000 Kw. HIGH PRESSURE TURBO ALTERNATOR AND CONDENSING PLANT.

Specifications and Drawings may be obtained from the undersigned on payment of a deposit of One Guinea, which will be returned on receipt of a bona-fide Tender.

Tenders are to be received by first post Thursday, August 12th.

W. A. VIGNOLES, Lt.-Col.,
Borough Electrical Engineer.

Corporation Electricity Works,
Grimsby, June, 1920. H 442

G. R.

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD.
(PLANT AND MACHINERY SECTION).

BOILERS.

For Sale by Public Tender.

16 MARINE BOILERS.
16 Yarrow Type MARINE TUBE BOILERS,
Heating surface 3,500 sq. ft., Working pressure 235 lbs.

For full particulars, permission to view and Tender Forms, apply to CONTROLLER, D.B.I.e. (3), Charing Cross Embankment Buildings, W.C. 2.

Tenders close TEN a.m., JULY 10th, 1920.

NOTE.—For particulars of other Government Property for Sale, see *Surplus*, price 3d. at all Bookstalls; or by quarterly subscription of 2s. post free in the United Kingdom, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1. H 490

G. R.

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD
(PLANT AND MACHINERY SECTION).

For Sale by Tender.

THREE DIESEL ENGINES, DYNAMOS AND COMPRESSORS.

One Willans DIESEL OIL ENGINE (No. D. 110), by Willans & Robinson, Rugby, with Compressor and Dynamo, direct coupled. Space 28 ft. by 10 ft., height from floor level 14 ft.

ENGINES, 4 cylinder, 320 B.HP., 9 ft. Flywheel, 250 r.p.m. One Filter Tank for fuel oil, rectangular, steel. One Fuel Oilfeed Tank, cylindrical, steel rivetted. One set 4 ton Chain Blocks.

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One Starting Bottle, 5 ft. by 15 in. ext.
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Air Bottles, tested to 1,500 lbs. per sq. in., gauges calibrated 0-1176 lbs.

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Two Insulated Links, one single-pole Circuit Breaker, 1000 amps. over load trip.

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B fitted with Field Regulator.

Also a quantity of Spare Parts.

Two Willans DIESEL OIL ENGINES (Nos. S.D. 96 and 114), by Willans & Robinson, Rugby, with Compressors and Dynamos, direct coupled.

Space occupied 24 ft. by 10 ft., height from floor level 14 ft.

ENGINES, 3 cylinder, 240 B.HP., 9 ft. Flywheel, 230 r.p.m. One Filter Tank for fuel oil, rectangular, steel. One Fuel Oilfeed Tank, cylindrical, steel rivetted. One set 3 ton Chain Blocks.

AIR COMPRESSOR, by Reavell & Co.

DYNAMO, by Phœnix, 170 Kw., 220 volts, 230 r.p.m., 6 pole, compound wound.

Also a quantity of Spare Parts.

For full particulars, list of spares, permits to view, and Tender forms, apply to the CONTROLLER, D.B.I.e. (1), Charing Cross Embankment Buildings, W.C. 2.

Tenders close July 7th, 1920, at Ten a.m.

NOTE.—For particulars of other Government Property for Sale, see *Surplus*, price 3d. at all Bookstalls, or by quarterly subscription of 2s. post free in the United Kingdom, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1. H 491

IN BANKRUPTCY.

ENDACOTT & BROWNE,
BY ORDER OF THE TRUSTEES.

For Sale by Tender as a Going

Concern, the BENEFICIAL INTEREST in the Lease of the EXCELLENT MODERN FACTORY PREMISES, Nos. 22/23, VERULAM STREET, HOLBORN, W.C.

Together with the whole of the VERY VALUABLE PLANT AND MACHINERY, STOCK-IN-TRADE AND GOODWILL, connected with the business of the ENDACOTT SCIENTIFIC INSTRUMENT COMPANY, Manufacturers of Optical and Scientific Instruments, comprising all the necessary equipment for the complete manufacture of Binoculars, Optical Instruments and Spectacle Lenses on up-to-date lines.

Forms of Tender and further information may be obtained of Messrs. ELLIS, SALAMAN, COATES & Co., Chartered Accountants, 1 & 2, Bucklersbury, Cheapside, E.C. 4; Messrs. SINGLETON, FABIAN & Co., Chartered Accountants, 8, Staple Inn, W.C.; Messrs. WOOLFE & WOOLFE, Solicitors, 16, Hanover Street, W. 1; and Messrs. HUMBERT & FLINT, Surveyors, 11, Serle Street, Lincoln's Inn, W.C. 2.

Tenders to be submitted to Messrs. HUMBERT AND FLINT, 11, Serle Street, Lincoln's Inn, W.C., before Twelve o'clock, on WEDNESDAY, JULY 21st, but the Trustees do not bind themselves to accept the highest or any Tender. H 495

PRELIMINARY ANNOUNCEMENT.

JAMES WHITELEY, LIMITED.
IN VOLUNTARY LIQUIDATION.

TO ENGINEERS, COMMERCIAL MOTOR MANUFACTURERS, TEXTILE MACHINISTS, IRON FOUNDERS, STEEL FOUNDERS CAPITALISTS, COMPANY PROMOTERS and others.

The Valuable Freehold

FACTORY, FOUNDRY and PREMISES, together with PLANT and MACHINERY, FIXTURES and GOODWILL of JAMES WHITELEY, LIMITED, FOR SALE by TENDER.

THE FACTORY contains a complete Plant and Foundry Equipment for the manufacture from the raw materials of a Commercial Motor Chassis, every part being made in the Factory with the exception of the Tyres, Carburettor, Magneto and Timing Chain.

THE FOUNDRY is equipped for making every Casting on the Chassis, including Cylinder Castings, Semi-steel Castings, Aluminium Crank-cases, etc., etc.

THE PRODUCE being manufactured is a 30 cwt. Chassis, this size of Chassis being in almost universal demand. The Product is standardised, jigged, etc., and 70 per cent. of the Patterns are on plate.

Part of the Plant and Machinery is almost new, and the whole is in excellent working order.

THE OFFER presents an excellent opportunity for acquiring an Engineering Manufacturing Proposition which can be carried out on Mass Production Lines, and which is of great value.

THE FACTORY contains 50,000 sq. ft. of covered floor space, and is situated within five minutes from two Halifax passenger and goods stations, and is in the best manufacturing part of Halifax.

Form of Tender and Catalogue of Works are in course of preparation, and will be sent, when ready, on application, and for further particulars and permission to view, apply to MOORE & SHEPHERD, Barum House, Halifax, Solicitors, or to

FRANK S. MITCHELL,
8, Wards End, Halifax,
J. W. KNEESHAW,
Chartered Accountant,
Bank Chambers,
Hargreaves Street, Burnley,
Joint Liquidators.
H 496

SUMMERSCALES LIMITED, KEIGHLEY.

PRELIMINARY to SALES by AUCTION.

Tenders are Invited for the

SALE by PRIVATE TREATY, of the whole of the

PATTERNS, DRAWINGS, PATENTS, ELECTROS, and GOOD WILL and VALUABLE CONNECTION of SUMMERSCALES LIMITED, LAUNDRY ENGINEERS' BUSINESS, together with the NAME and WORLD-WIDE REPUTATION of SUMMERSCALES LIMITED, and the exclusive right to use such name.

There is Work in PROGRESS and COMPONENT PARTS of MACHINES necessary for the continuance of the manufacture of this Class of Machinery and for the execution of REPAIRS and RENEWALS, the purchase of which at Cost Price or Valuation, together with all the Recent (illustrated) Catalogues is conditional upon the purchase of the Patterns, &c.

The Purchaser to be supplied with a full List of Customers.

(N.B.—The Patents under which the "THRESH" DISINFECTOR is manufactured are not included in the above.)

also

TENDERS are Invited, under SEPARATE TREATY, for the PATTERNS, ELECTROS and DRAWINGS of this Company's VALUABLE BUSINESS of MANUFACTURERS of SQUEEZING MACHINERY for use on RUBBER PLANTATIONS.

Such WORK as may be in PROGRESS, COMPONENT PARTS of MACHINES, REPAIR PARTS and RENEWALS and the STOCK of RECENT (illustrated) CATALOGUES shall be taken by the Purchaser of the Patterns, &c., at Cost Price or Valuation. The Purchaser to be supplied with a full List of Customers.

All Tenders must be received at the Offices of the undersigned, not later than 12 o'clock, noon, on Thursday, July 15th, 1920.

SALES by AUCTION of the whole of the MACHINERY and PLANT, FREEHOLDS and other EFFECTS are under preparation, the dates of which will shortly be advertised.

DAVIS, SHORESMITH & MARSHALL, Auctioneers, 11, Harrison Road, Halifax.

WHITHAM & TURNEY, Chartered Accountants, 6, Harrison Road, Halifax. H 498

[JULY 2, 1920. VOL. CX.]

ENGINEERING.

ON CHAIN DRIVING THEORY.

By F. M. Lawson.

To a commercial mind, perhaps the first appeal of any proposition in engineering is with regard to the practical issues which are likely to result from its direct application. The commercial mind is not so much concerned with the theories involved, but prefers to examine them in the light of actual practice. The true theorist, on the contrary, prefers to commence from first principles, adopting as his base a point as in Euclid. From this beginning he sets down his proposition and deduces the facts which may be inherent although not always self-evident. He is content that the theory shall be subjected to the most careful scrutiny in its smallest detail, and is not satisfied unless the test of actual practice be applied in order that his conclusions may be proved to be sound.

Research work connected with chain driving is undoubtedly difficult, since in any chain drive there are at least a score of variable factors, the alteration of any one of which may involve alteration of several others. The following list gives 20 variable factors: (1) Number of teeth in wheels; (2) revolutions per minute of wheels; (3) ratio of reduction; (4) inclination of drive; (5) material wheels made of; (6) steadiness of load; (7) speed of chain; (8) pitch of chain; (9) lubrication of chain; (10) pull on chain; (11) centre distance; (12) inclination of chain; (13) type of chain; (14) design of chain; (15) length of chain; (16) tension on slack side of chain; (17) bearing pressures; (18) weight of chain; (19) accuracy of manufacture of chain; (20) accuracy of manufacture of wheels.

Looking at the above list it will be observed that if one factor is altered and a different result obtained it will be impossible to say whether the difference is due to the original factor being altered or to one of those factors which is affected by its alteration. For instance, increasing the number of teeth in a driver wheel may give a longer life, but is this longer life due entirely to the number of teeth being altered? Is it not also due to the fact that by increasing the number of teeth the pull in the chain is decreased and the bearing pressure reduced? Or, again, would not the life have been increased still further if the alteration had not affected the speed of the chain?

Tests would have to be carried out *ad infinitum* to establish any definite theory which in itself is an absurdity, so that if any theory can be outlined which will enable those engaged on practical research to direct and concentrate their energies along defined paths their time will be saved and progress made.

Now, to follow in Euclid's footsteps, what is the point common to all chain drives?

In considering a chain drive the simplest form may be stated to consist of a driver wheel, a driven wheel, and a length of endless chain, the utility of the chain being to transmit power from the driver wheel to the driven wheel. The chain consists of a series of links connected by studs, so that the centre of all studs in the chain travel along the same path; consequently if the path of one stud can be definitely located, the paths of all studs at any position in the chain drive are located, and this stud path in its relation to the wheels is common to all chain drives and consequently may be considered as the starting point, for it is a line generated by a point.

Fig. 1.

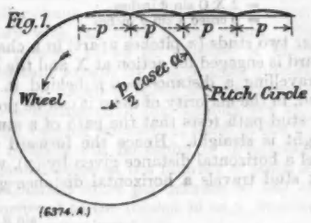
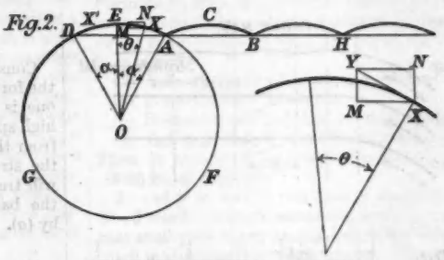


Fig. 2.



Now a stud in a chain 1-in. pitch running at 500 ft. per minute moves a pitch length in $\frac{1}{500 \times 12}$ second, so that it is impossible to see the path of any one stud although the light wave of the path of all studs may be observed under favourable conditions. The practical value of this light wave cannot be exaggerated, but it has one drawback for research in that it is not capable of measurement, and consequently a method had to be adopted to obtain actual stud paths at high speeds which could be measured. The method the author adopted, and it is a method which has the advantage of being simple, is as follows:—

To one of the studs in a chain a stiff pointer was fixed extending about $\frac{1}{8}$ in. beyond the width of the chain. When the chain was running a board covered with beeswax was moved towards the chain so that the pointer scratched the path in the wax. In order to simplify the mechanism, records were taken separately at four different places: (1) Entering driver wheel; (2) leaving driver wheel; (3) entering driven wheel; (4) leaving driven wheel.

In this paper the author has concentrated on the first division knowing that if this is solved the three remaining divisions can be solved in the same way. Before dealing with these practical results it is necessary to investigate the theory, for, although chain drives have been on the market over thirty years, no satisfactory theory has yet been published as far as the author knows, and consequently the following is the result of research.

Theory.

The "true" pitch circle diameter of a whee may be calculated from the formula:

$$\text{Pitch circle dia.} = p \operatorname{cosec} a \text{ inches} \quad . \quad . \quad (a)$$

Where p = pitch in inches,

Tr = Number of teeth in driver wheel (or driven wheel Tn),

and $a = \frac{180}{\text{Tr}}$.

The speed in feet per minute of any point on the pitch circle is equal to:

$$\frac{\pi p N \operatorname{cosec} a}{12} \text{ feet per min.} \quad . \quad . \quad . \quad (b)$$

Where N = revolutions per minute.

If the chain is running towards the wheel the "straight" speed is equal to:

$$\frac{p N \text{Tr}}{12} \text{ feet per min. or } \frac{180\, p N}{12\, a} \text{ feet per min.} \quad . \quad (c)$$

It must be noted that the speed (*b*) is always greater than the speed (*c*) since the linear measurement of the circumference of the "true" pitch circle is always greater than the linear measurement of a polygon composed of Tr sides of length p. Or expressed otherwise:

$$\text{Speed } (b) : \text{speed } (c) :: a : \frac{180}{\pi} \sin a \quad . \quad . \quad (d)$$

and a is always greater than $\frac{180}{\pi} \sin a$.

At first sight there appears to be a difficulty in accounting for two speeds because the centre of one stud may be travelling circumferentially at a higher speed than the centre of a stud behind it, which is travelling in the straight line. It is accordingly necessary to analyse the straight speed and see what is meant by this.

Firstly at dead slow speed it is obvious that the path of a stud travelling towards the driver wheel is composed of arcs of the "true" pitch circle, the chord of the arc being equal to p, see Fig. 1. (For

convenience these arcs are afterwards referred to as "pitch arcs.")

Take the case of a wheel which is travelling without cyclic variation; the speed at any point on the arc is constant. In Fig. 2, let

E F G = pitch circle
D A = pitch = A' B' = B H.

The velocity at any point X in the pitch circle may be resolved into horizontal and vertical velocities—the horizontal velocity being proportional to X M, the vertical velocity proportional to X N, when X Y represents the velocity at the point X which may be found from formula (*b*).

Hence X M = horizontal velocity at point X.
= X Y cos M X Y.
= X Y cos θ, where θ = X O E.
And X N = vertical velocity at point X.
= X Y sin M X Y.
= X Y sin θ.

Now X Y from formula (*b*),

$$= \frac{\pi p N}{12} \text{ cosec } a \text{ f. p. m.}$$

Hence horizontal velocity at any point X

$$= \frac{\pi p N}{12} \text{ cosec } a \cos \theta \text{ feet per min. . } (e)$$

And vertical velocity at any point X

$$= \frac{\pi p N}{12} \text{ cosec } a \sin \theta \text{ feet per min. . } (f)$$

It follows that the horizontal velocity at the point A, where $\theta = a$

$$= \frac{\pi p N \cot a}{12} \quad . \quad . \quad . \quad . \quad (g)$$

which, when a is acute, is always less than speed (*c*)

And since speed (*c*) is always less than speed (*b*), which is the horizontal velocity at the point E, there must be some point between A and E at which the horizontal velocity equals speed (*c*). To find it:

Let X be the point.

The horizontal velocity of X $= \frac{\pi p N}{12}$ cosec $a \cos \theta$ by (*e*)

and the speed (*c*) is $\frac{180 p N}{12 a}$

These are equal if π cosec $a \cos \theta = \frac{180}{a}$

or $\cos \theta = \frac{Tr \sin a}{\pi} \quad . \quad . \quad . \quad . \quad . \quad . \quad (k)$

The various values of θ for different values of Tr are given in the following table.

TABLE I.

Tr	θ.	Log Cos θ.
10	10 deg. — 22·86 min.	9·9928325
15	6 deg. — 54·84 min.	9·9968303
30	3 deg. — 27·82 min.	9·9992060

The value of having located the point X by knowing the angle θ is that this point may be known as the point at which "action" commences, or in other words the point at which the horizontal speed of the pitch circle path begins to get greater than the straight speed of the chain.

In order to simplify reference to this point later it appears advisable to give some definition to the portions of the arc A E D.

Let A X be termed the period of inaction,
X E be termed the period of action,
E X^1 (where E X^1 = E X) be termed the period of reaction.
X^{1}D be termed the second period of inaction,
Where X is located by the angle E O X whose cosine = $\frac{Tr \sin a}{\pi}$

Point of Impact.—It is obvious that the point A on the pitch circle may be accepted as the theoretical point of impact.

In Fig. 3, A K represents the direction of pull of chain at point A and A L represents the direction of pull from wheel at point A.

The pull A K = pull A L. Hence impact pull A J must be such as will make A L the resultant of A K and A J.

Now

$$\frac{AJ}{2} = AL \sin a$$

or

$$AJ = 2AL \sin a$$

Now if A K which = A L = pull on chain, the vertical impact blow must be equal to

$2f \sin a$ where f is the pull on the chain . (*m*)

The following table gives values of vertical impact blow for various numbers of teeth, when the speed is such that the point of impact is the point A.

TABLE II.

Tr.	Impact in Terms of Pull.
6	pull × 1·0
9	pull × 0·684
10	pull × 0·618
12	pull × 0·518
15	pull × 0·416
18	pull × 0·347
20	pull × 0·313
30	pull × 0·209
45	pull × 0·134
60	pull × 0·105
90	pull × 0·067

What Happens during the Period of "Action" and "Reaction."—The period of action commences at a point X, which is found by the angle θ being known from formula (*k*):

i.e., $$\cos \theta = \frac{Tr \sin a}{\pi}$$

So, since the total period of action and reaction: arc A E D :: $\theta : a$ it follows that between X and X^1 the chain in the straight will have travelled a horizontal distance

$$= \frac{\theta}{a} p \text{ inches} \quad . \quad . \quad . \quad . \quad (o)$$

and between X and X^1 the wheel will have travelled a horizontal distance

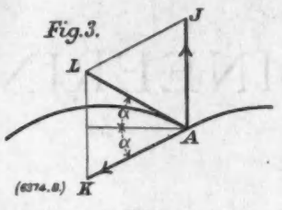


Fig.3.

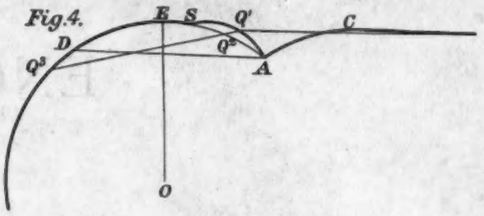
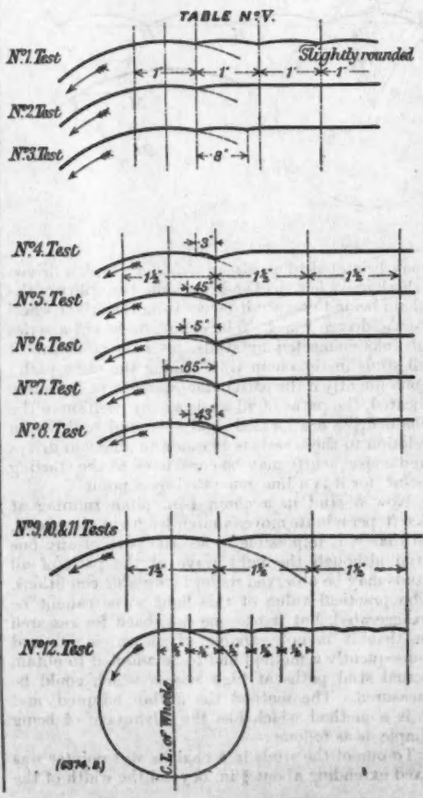


Fig.4.

TABLE IV.—TESTS CARRIED OUT AT THE WORKS OF MESSRS HANS RENOLD, LIMITED, MANCHESTER.

Test No.	Type of Chain.	Pitch of Chain.	T r.	T n.	R.P.M.	F.P.M.	Pull.	Approx. H.P.	Centres. Inches.	Lubrication.
		in.								
1	Roller.	1	17	17	1,000	1,420	230	10	Long	None.
2	Roller.	1	17	17	1,000	1,420	230	10	30½	Oiled.
3*	Roller.	1	17	17	1,000	1,420	230	10	30½	Oiled.
4	Roller.	1½	10	30	450	560	—	—	45	Oiled.
5	Roller.	1½	10	30	900	1,125	—	—	45	Oiled.
6	Roller.	1½	10	30	1,200	1,500	220	10	45	Oiled.
7	Roller.	1½	10	30	1,200	1,500	—	—	45	Oiled.
8	Roller.	1½	10	30	900	1,125	73	2½	45	Oiled.
9	Silent.	1½	15	54	1,200	2,250	36	2½	45	Oiled.
10	Silent.	1½	15	54	900	1,700	48	2½	45	Oiled.
11	Silent.	1½	15	54	450	850	96	2½	45	Oiled.
12	Silent.	½	15	15	1,040	650	920	18	—	Oil pump.

* In test No. 3 the point was attached to the rear stud of outside link. In all other cases it was attached to forward stud on outside link.



= chord X X^1
= 2 X O sin θ inches
= p cosec a sin θ inches . . . (*p*)

Consider two studs (n pitches apart) in a chain—the forward is engaged for action at X and the back one is travelling a distance = $n p$ behind it. At high speed, in the majority of cases it can be proved from the stud path tests that the path of a stud in the straight is straight. Hence the forward stud will travel a horizontal distance given by (*p*), while the back stud travels a horizontal distance given by (*o*).

Also $$\frac{\text{the distance } (p)}{\text{the distance } (o)} = \frac{p \text{ cosec } a \sin \theta}{\frac{\theta p}{a}} = \frac{\frac{\sin \theta}{\theta}}{\frac{\sin a}{a}}$$

Now $\frac{\sin \theta}{\theta}$ is known to decrease as θ increases.

Hence the distance (p) is greater than the distance (o)

Consequently a certain amount of elasticity is called for in the chain between the forward stud and the stud n pitches behind it when the stud path of the latter is straight. The measurement of this elasticity may be found by subtracting the distance (o) from the distance (p). Or elasticity required during period of action and reaction:

$$= p \text{ cosec } a \sin \theta - \frac{\theta p}{a} = p \left(\frac{\sin \theta}{\sin a} - \frac{\theta}{a} \right) \quad (q)$$

when θ is given by

$$\cos \theta = \frac{Tr}{\pi} \sin a$$

and $$a = \frac{180}{Tr}$$

The various values for varying numbers of teeth, when p = 1 in, are given in the following table:

TABLE III.

Tr.	p. In.	$\left(\frac{\sin \theta}{\sin a} - \frac{\theta}{a} \right)$
10	1	0·00640
15	1	0·00283
30	1	0·00070

Or, when β and a are small, this formula (q) may be written:

Elasticity required during period of action and reaction

$$= \frac{0.64\,p}{\mathrm{Tr}^2} \quad . \quad . \quad . \quad . \quad (r)$$

How does Impact affect the Life of a Chain?—Damage done by impact may be considered under two headings:—

1. Invisible damage such as fatigue of material.
2. Visible damage such as the loss or malformation of metal from the tooth of a wheel, back of liner, face of silent link, surface of roller, &c.

These two types of damage at first sight involve complications in arriving at a life formula. If, however, a chain drive has a reasonable factor of safety the invisible damage or fatigue of material does not exist as a potential factor, but it is undoubtedly the factor which comes into evidence when tests are carried out under abnormal conditions such, for instance, as a life test on a chain with a factor of, say, 4 on a 15-tooth wheel running at a high speed. On such a test as this the chain fails after a few hours through fatigue of material, and the test is consequently almost valueless for commercial purposes, since few, if any, drives fail in this way, and those which do fail may be due to other causes, such as a low factor having been created by an excessively tight chain. In other words, these tests are similar to Wöhler's researches, which proved that parts subjected to variations of stress for long periods must be provided with a higher factor of safety than parts subjected to a steady load.

Hence for practical purposes damage which is only visible under the microscope may be overlooked, but it must not be forgotten when complaints arise since it is then a potential factor.

Visible damage creates malgearing, and the greater the damage the greater the malgearing, and consequently the greater the impact. Summing this up it appears as if damage accumulates at compound interest—thus, if a chain has increased in pitch 1 per cent. during five years it will certainly have increased more than 2 per cent. in ten years, and may quite conceivably have increased to 2 per cent. in six years. This compound interest may possibly be reckoned as constant for one type of chain, but the constant is hardly likely to be the same for a roller chain as for a silent chain; moreover, it may vary with the pitch of the chain. There appears at present to be no method of arriving at this constant except by the lengthy process of testing.

Some useful purpose will be gained by arriving at a comparative life formula for any one chain with varying numbers of teeth in the wheels. Such a formula will be useful in determining the commercial value of the number of teeth in a wheel.

Damage done per minute to the studs is proportional to the impact blow × number of times it occurs per minute.

$= 2f \sin a \times \mathrm{N\,T}r$, using formula ($m$).

N being the R.P.M. and f the pull on the chain.

Life of the chain varies as

$$\frac{\text{Number of studs}}{\text{damage per min. to the studs.}}$$

If L = length of chain, number of studs $= \frac{L}{p}$

$$\therefore \text{ Life of chain varies as } \frac{\frac{L}{p}}{2f \sin a\, \mathrm{N\,Tr}}$$

$$= \frac{L}{2f\,p\,\mathrm{N\,Tr} \sin a}$$

Now the drive is given, $\therefore f \times$ speed of chain is constant

$\therefore \frac{f\,p\,\mathrm{N}}{12}\mathrm{Tr}$ is constant, using formula (c)

$\therefore$ Life of chain for a given drive varies as

$$\frac{L}{\sin a} \text{ where } a = \frac{180}{\mathrm{Tr}} \quad . \quad . \quad . \quad (s)$$

Example.—A 10-h.p. drive, 600 r.p.m. to 200 r.p.m., centres 4 ft., chain 1 in. pitch. Which drive is the best commercial proposition, the drive arranged with 15 T and 45 T, making the cost of the drive 20*l.*, or a drive having 20 T and 60 T costing 24*l.* Length of chain for the 15 T drive, say, 126 in. Length of chain for 20 T drive, say, 136 in.

Life of 15 T drive : life of 20 T drive :: 126 cosec 12 deg. : 136 cosec 9 deg.

:: 603 : 870

making commercial value of life

:: £20 : £29.12.0

whereas

cost of 15T drive : cost of 20T drive :: £20 : £24

Hence the 20 T wheel drive is a better commercial proposition.

It must, of course, be borne in mind that there is a limit to the number of teeth which can be used, for, when a chain wears, it gets out of gear quicker with a large wheel than a small one.

This question of damage by impact opens up a strong case for small wheels, being of the same hardness as the portion of the chain which engages with the wheel.

Thus in the case of roller chain wheels with only a few teeth, these should be hardened since the roller of the roller chain is hardened, but in the case of small wheels for chains in which unhardened links engage with the wheels, it is probably sounder policy to have a mild steel wheel unhardened.

Stud Path Tests.—Mention has already been made of the method adopted to record on wax the actual path of a stud. Particulars of a few of these tests are given in Table No. IV, and the salient points reproduced in Table V.

Tests Nos. 1, 2 and 3 may be grouped and termed lubrication tests since the only altered factor between No. 1 and 2 was oil, and between No. 2 and 3 the only alteration was that the chain was reversed so that the point scribed the path of the stud at the rear end of the outside link.

Much valuable information can be obtained from these three stud paths. In the first place (test No. 2) the stud path leading up to the wheel assumed a straight line when the chain was oiled, whereas when the chain was bone dry (test No. 1) the path showed a series of arcs with slightly rounded joints. Secondly, when the pointer was placed on the rear stud of the outer link (test No. 3) the path showed a straight line finishing off with one arc before entering the wheel.

The only possible explanation for the difference in path before and after oiling lies in the theory that lubrication supplied the necessary elasticity. Formula (r) gives the necessary elasticity in this case to be 0·0022 in.—which elasticity in test No. 2 might be provided by oil in any one of the following four places.

(a) Between tooth of wheel and roller of chain.
(b) Between roller and bush.
(c) Between bush and stud in engagement.
(d) Between bush and stud behind engagement.

Thus it appears that each film of oil supplied ·0006 in. of elasticity.

In order to test if this theory was correct, test No. 3 was tried since lubrication could not affect the rear stud path of an outside link when this was one pitch in distance from engagement. The result here proved the case; the path being a straight line ending with an arc before engagement with the wheel. The measurement of this arc, *i.e.*, 80 per cent. of the pitch of the chain should be noted—the probable explanation lies in the fact that the rear stud continued to drop until the forward stud reached the point of action.

Nos. 4, 5, 6, 7 and 8 may be termed impact tests, and would have been more complete if they had been duplicated with the pointer on the rear stud of the outside link, and if the horse-power could have been accurately measured.

All these tests were severe—a 10 T driver wheel and chain speeds varying from 560 ft. per minute to 1,500 ft. per minute.

Tests Nos. 4, 5 and 7 had no appreciable load and speeds alone were varied. The effect of impact was clearly marked on the stud path, the stud being actually "thrown" by impact off the pitch circle path. In No. 4 test it was thrown for 20 per cent. of the pitch arc; in No. 5 test for 30 per cent. of the pitch arc, and in No. 7 for 55 per cent. of the pitch arc. No. 8 test gave the same result as No. 5, which might be expected since the only alteration was a slight increase in horse-power which could not be accurately measured. Test No. 6 was similar to test No. 7, the only difference being a considerable increase in horse-power transmitted. The length of the throw path was considerably less, having decreased to 33 per cent. of pitch arc from 56 per cent.

In none of these tests were there any signs of arcs in the path leading to the wheel, but in every case the path dropped to the point of impact. If formula (r) is applied to tests Nos. 4 to 8, it will be found that the elasticity required is 0·0096 in. Before considering how this elasticity is provided it is advisable to state the two facts that have been established by these five tests.

1. Impact can throw a stud off its normal path.
2. To some extent the length of the throw varies with the speed and inversely with the pull of the chain.

In tests Nos. 1, 2 and 3 it was found that lubrication provided 0·0022 in. of elasticity—possibly, from the fact that tests Nos. 4 to 8 were run with 1½-in. pitch chain, whereas tests Nos. 1 to 3 were run with 1-in. pitch chain, it might be argued that more elasticity could be expected, but a detail investigation of the throw path proves that, if the stud can be thrown off its path, elasticity is not necessary to the extent provided for in formula (r).

In Fig. 4, let A Q^1 S represent the throw path, A being the point of impact.

Now the length of the line A Q^1S D is greater than the length of the line A Q^2S D.

Hence the stud path speed is greater from the point A than is represented by speed (b).

But

$$\frac{\text{Speed } (b)}{\text{Speed } (c)} = \frac{a}{\frac{180}{\pi} \sin a}$$

which is constant for any given wheel.

Hence if speed (b) is increased by impact, speed (c) is increased in the same proportion.

But the straight stud path is straight, hence the straight speed must be greater than that supplied by speed (c). In other words the effect of the throw path is equivalent to increasing the pitch circle diameter, which, in turn, increases the straight speed and so reduces the difference between speed (b) and speed (c).

It is thus obvious that if sufficient elasticity cannot be supplied by the chain and wheel either a throw path must exist, or else the chain in the straight will "pitch arc."

It must be noted from these tests, Nos. 4 to 8, that the length of the throw path varies, that, in fact, it increases with the speed of the chain and decreases with the load. It must also be noted from Fig. 4 that when the centre of the stud is on the throw path it is not in gear with the wheel and does not come into gear with the wheel until it reaches the point S, hence action commences at S.

This explanation accounts for the reduction of length of throw path in test No. 6, as compared with test No. 7. No. 7 test was taken with the chain running with practically no load so that it was only necessary for the wheel to impart a short push during the period of reaction and before the second period of inaction commenced.

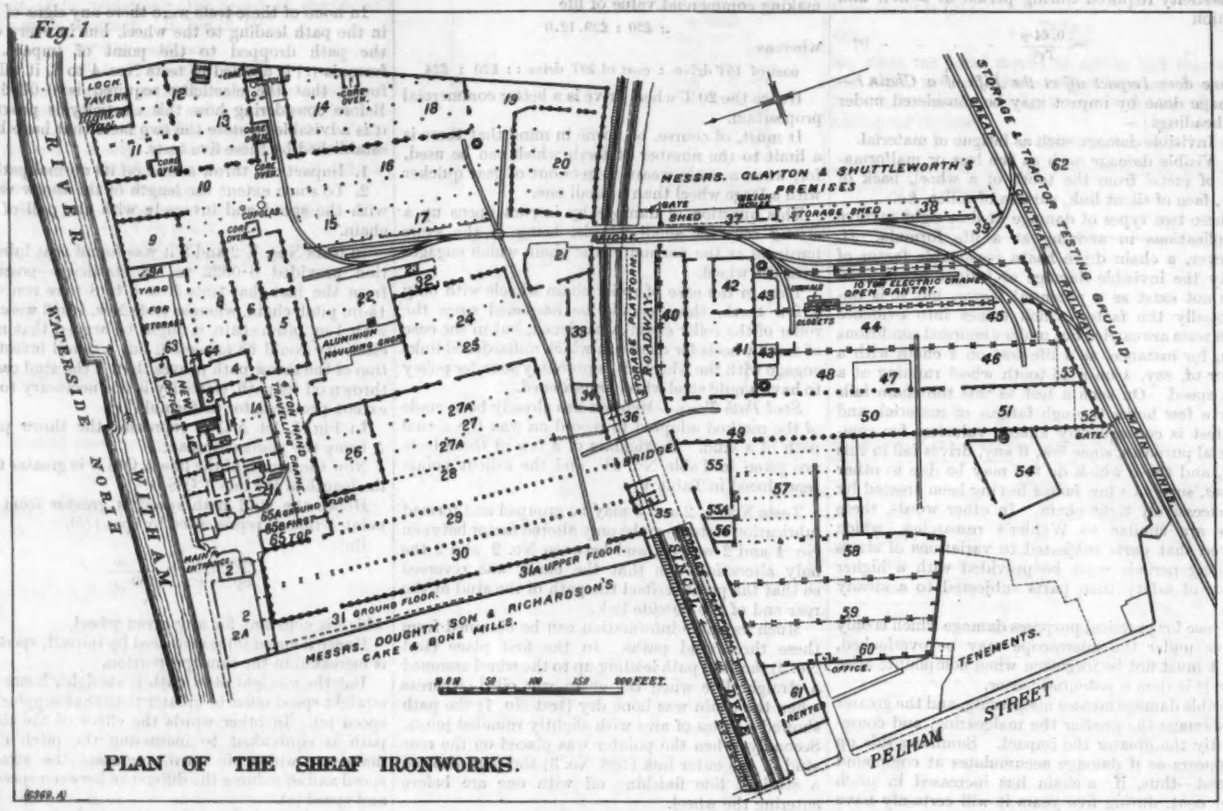
In test No. 7 the second period of inaction commences at a point which corresponds to 79 per cent. of the pitch arc. Whereas owing to the light load the period of action only commenced at a point corresponding to 56 per cent. of the pitch arc. In test No. 6 the load was increased and the period of action started at a point equivalent to 33 per cent. of the pitch arc.

When the speed is high and the number of teeth in a wheel is so low that a throw path exists, the effect on the chain is what may be described as vibratory whipping, this whipping being caused by a series of jerks from the teeth of the wheel. Whipping may exist owing to an impulsive load, but these two types of whipping can usually be distinguished by their frequency and depth—the impulsive load type being less frequent and of greater depth.

Tests Nos. 9, 10 and 11 were carried out with the arched link type of chain (commercially known as noiseless or silent type). The characteristic of these paths is in the easy curve at the point of impact—thereby showing that impact is absorbed gradually. A brief look at the design will show that the arch link when subjected to a sudden

THE WORKS OF MESSRS. RUSTON AND HORNSBY, LIMITED, LINCOLN.

Fig. 1



PLAN OF THE SHEAF IRONWORKS.

(6369.A)

INDEX TO FIG. 1.

No.	Description.	No.	Description.	No.	Description.	No.	Description.	No.	Description.
1.	Head offices.	12.	Machine moulding shop	27.	General turnery.	40.	Internal combustion engine testing	54.	Assembling shop.
1A.	Drawing offices.	13.	Light do. do.	27A.	Brass galleries.	41.	Electric power house.	55.	Fitting shop and stores.
1B.	Photo-copying.	14.	Do. do do.	28.	Heavy machining shop.	42.	Do. sub-station.	55A.	Oil and gas engine stores.
2.	Works offices.	15.	Sand grinding.	29.	Erecting and heavy grinding.	43.	Battery of boilers.	56.	Latrines.
2A.	Mess room.	16.	Heavy fettling, &c.	30.	Boring shop and erecting.	44.	Dismantling shop.	57.	General fitting shop.
3.	Office heating.	17.	Do. stamping shop.	31.	Finished parts stores.	45.	Packing shop.	58.	Portable engine erecting.
4.	Metal pattern shop.	18.	Light stamping shop.	31A.	Auto-machine tool gallery.	46.	Paint shop.	59.	Marine do. do.
5.	Wood do. do.	19.	Do. drop forging shop.	32.	Wheel shop and plant repairs.	47.	Acetylene welding shop.	60.	Do. do. do.
6.	Fettling shop.	20.	General smithy.	33.	Babbitting shop.	48.	Portable steam engine testing.	61.	Copper pipe shop.
7.	Castings, grindery.	21.	Heavy hammer forge.	34.	Electric welding shop.	49.	Large gas and oil engine testing	62.	Tractor trials, &c.
8.	Semi-steel moulding shop.	22.	Semi-steel muffling.	35.	Ambulance rooms.	50.	Fixed engine testing shop.	63.	Motor garage.
9.	Pattern shop store.	23.	Latrines.	36.	First aid dressing station.	51.	Tractor and road roller erecting	64.	Air compressing room.
9A.	Small core making.	24.	General milling and turnery.	37.	Bar steel storage shed.	52.	Electricians' gallery.	65.	Laboratory, &c.
10.	Heavy moulding shop.	25.	Planing machine shops.	38.	Do. and wood shed.	53.	Lettering painters' gallery.	65A.	Order office.
11.	Brass do. do.	26.	General stores.	39.	Paint and petrol store.			65B.	Buying department.

load can supply elasticity by elongation and that the effect of this elongation is to produce gearing at that part of face of link furthest from the stud centre. This means more gradual engagement and explains the reason for this design being, under normal conditions, quieter than the roller design. Lubrication also supplies elasticity as in the roller tests.

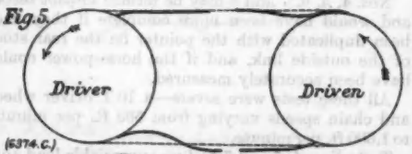
Test No. 12 was carried out with a load which gave a very low factor of safety—the stud path is most instructive—without resorting to the wax board it was easy to see the light waves throughout the length of chain between driver and driven wheel. It will be noticed that this wave is similar to that obtained in No. 1 test (*i.e.*, when lubrication was absent), but in No. 12 test oil was being pumped into the chain; however, the bearing pressure on the studs was so great that oil could not reach the surface.

These few tests are given to show that the practical results obtained agree with the theory, and that having established a portion of the theory the complete theory can be developed together with the practical stud path tests. For the value of the stud path test is one which no firm of chain makers can afford to overlook.

Before closing the subject it is necessary to place on record a few notes connected with the chain leaving the driver wheel, entering the driven wheel, and leaving the driven wheel.

When a chain is running at a fairly high speed with wheels having a small number of teeth, it will be observed that it takes an inward curve after leaving the wheel as shown in Fig. 5. This can be seen in both cases, *i.e.*, leaving the driver wheel or leaving the driven, and is accounted for by the fact that the speed (*b*) is greater than the straight speed (*c*). In consequence, since the chain cannot alter from one speed to another instantaneously, it is necessary for it to assume a curve whose function is deceleration.

Fig. 5.



(5374.C.)

Tangential Line dotted

The same theory can be applied to the chain entering the driven wheel as has already been applied to it entering the driver wheel. The speed has to increase from speed (*c*) to speed (*b*)—T n being of course inserted in obtaining the value of *a*. This speeding up occurs by impact supplied from the driven wheel, and since there is no load being transmitted and the chain is slack the throw path will be found to be so serious as to prevent a very slack chain being run at a high speed with a small driven wheel, since the chain will then get thrown out of gear with the wheel.

With these few observations, with the point as in Euclid having been defined, the author feels that he can safely leave the question of chain driving for chain makers to develop.

THE LINCOLN WORKS OF MESSRS. RUSTON AND HORNSBY, LIMITED.

THE firm of Messrs. Ruston and Hornsby, Limited, is an amalgamation of those of Messrs. Ruston, Proctor and Co., Limited, of Lincoln, Messrs. Richard Hornsby and Sons, Limited, of Grantham, and Messrs. J. and H. Andrew and Co., Limited, of Stockport, the combination employing some 8,600 hands at their various factories and doing an extensive engineering trade in every quarter of the world. The largest of the component firms was that of Messrs. Ruston, Proctor and Co., Limited, which had its origin in the small millwrights' business of Burton and Proctor. The late Mr. Joseph Ruston became a partner in this business in 1857 when the name was changed to that of Ruston, Proctor and Co. It was formed into a limited company in 1889, Mr. Joseph Ruston being chairman until his death in 1897. The firm made its reputation on agricultural engines and machinery and in 1876 it commenced the manufacture of steam navvies, of which the present company are the largest and most

important constructors in the kingdom. Later, oil engines were taken up, and these have been continuously developed until now the company are producing engines of their own design which will start from cold, use any crude or residual oil as fuel, and give, it is claimed, an economy equal to that of the Diesel engine without its complications. This we shall deal with later. Gas engines and producers have become another speciality, particularly for the production of power from waste substances such as sawmill refuse, nut shells, plum stones, sugar cane refuse and cotton-seed and olive refuse. Exhaust heat boilers for utilising the waste heat in the exhaust gases of internal-combustion engines for the production of steam are another development, while the company also makes, on a large scale, road rollers, oil-driven locomotives, centrifugal pumps, maize shellers, threshing machines, clover hullers, baling presses, rice hullers, and so on.

Richard Hornsby and Sons, Limited.

The beginnings of this firm were in a small wheelwright's shop started by Mr. Richard Hornsby, on the Great North-road, at Grantham, in the year 1815. Small agricultural machines were made later, worked by horse or hand power, and in time the manufacture of agricultural steam engines, threshing machines and elevators was taken up. The Hornsby portable steam engine was awarded the first prize at the Great Exhibition of 1851, and the firm also acquired an early reputation for mowers, reapers and self-binding harvesters which have continued to hold their own in spite of foreign competition. The company was incorporated in 1879. A noticeable step in its progress was the acquisition of the Ackroyd-Stuart oil engine patents in 1901, and the manufacture of the Hornsby-Ackroyd type of engine which took perhaps the leading part in establishing oil engines as commercial and reliable prime movers. The firm achieved another success in 1905 when it entered a Government competition for the best military tractor that would complete a journey of 40 miles carrying its own fuel. Messrs. Hornsby entered a vehicle propelled by a two-cylinder oil engine, and not only secured the first prize of 1,000*l.*, but were awarded an additional bonus of 180*l.* for exceeding the requirements stipulated. It is of particular interest to note that immediately after the competition the wheels of this same tractor were removed and replaced by a chain-track, the invention of Mr. David Roberts, managing director of the company. In this form it attracted the attention of the Holt Company of the United States, who entered into arrangements with Messrs. Hornsby for the rights of manufacture. The "Caterpillar" tractor, as it was nicknamed by the soldiers during its first trials at Aldershot, was produced in considerable quantities for agricultural purposes by the Holt Company, to whom the name and the credit for the original invention is often wrongly attributed. But, as in so many other cases, the commercial development of the idea was left principally to foreign enterprise, and when the chain-track was adopted in the design of the military "tanks" used in the great war, it was generally thought to be a novelty so far as British engineers were concerned.

The amalgamation of Messrs. Richard Hornsby and Sons, Limited, with Messrs. J. and H. Andrew and Co., Limited, the makers of the well-known "Stockport" gas engine took place in 1906, and the present company possesses therefore the combined experience of three firms, each an expert in their own line, in the manufacture of oil and gas engines and producer plant, and their other specialities. In consequence of the amalgamation Messrs. Ruston and Hornsby, Limited, possess large works at Lincoln, Grantham and Stockport, but the present article will be confined to a description of the Lincoln works, which are to be visited by the Institution of Mechanical Engineers this month.

The Lincoln Works.

Messrs. Ruston and Hornsby, Limited, have five separate works in Lincoln. In the aggregate these works cover about 100 acres and give employment to something like 5600 work-people, and during the war to from 8 to 12 per cent. of the total population of the city. When the presence of several other large engineering works is taken into account, it will be realised how great an engineering centre Lincoln has become and how preponderant a part the city takes in the production of those classes of machinery with which its name is particularly associated. First and foremost amongst these was agricultural machinery of all kinds, but the output of steam-driven road vehicles, oil and gas engines, stationary steam engines and steam excavators now far exceeds in value the class of machines for which Lincolnshire still holds a virtual monopoly.

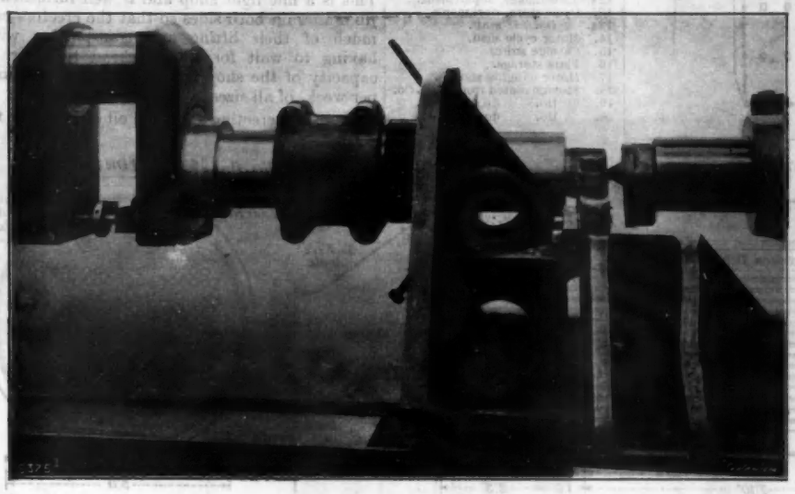


Fig. 2. Fixture for Screw Cutting.

The five Lincoln works of Messrs. Ruston and Hornsby are known respectively as (1) The Sheaf Iron Works, (2) the Wood Works, (3) the Motor Works, (4) the Boiler Works, and (5) the Steam Navvy Works, and it will be most convenient to deal with each separately, as they are practically separate establishments.

The Sheaf Iron Works.

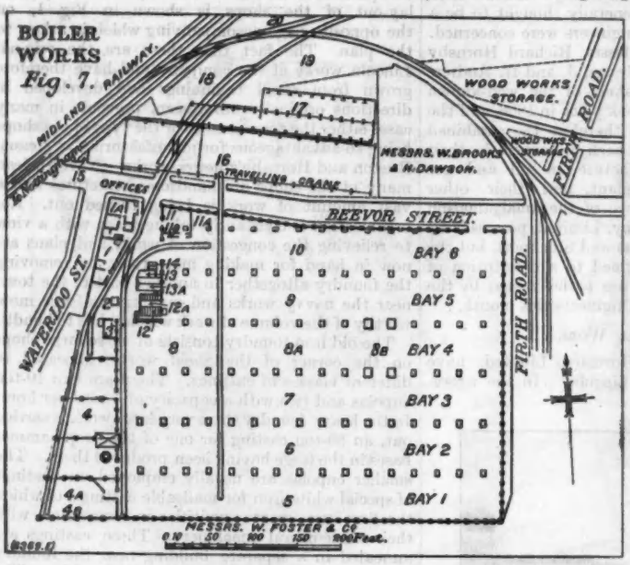
These works, where the head offices of the company are situated, lie alongside the river Witham, in the central part of the city. On the other side are the tracks of the Great Northern and Great Central Railways from which sidings enter the works. The principal productions of the Sheaf Iron Works are heavy oil engines, gas engines and producer plant, traction engines and road rollers, portable and semi-portable steam engines, oil locomotives, pumps, &c. About 2660 employees are occupied here and an average of something like 50 complete engines of all kinds per week is the normal production. In addition to this output these works serve as the central manufactory of a large proportion of spares for all the other works. The general lay-out of the shops is shown in Fig. 1, on the opposite page accompanying which is a key to the plan. The fact that these are the original Lincoln works of the company and have therefore grown from small beginnings and developed in directions originally unforeseen, prevents in many cases either the arrangement or the type of the shops being so advantageous for manufacturing as Messrs. Ruston and Hornsby's newer works. Nevertheless, many of the shops are handsome structures and a vast amount of work is being turned out. Reorganisation is constantly taking place with a view to relieving the congestion of work, and plans are now in hand for making more room by removing the foundry altogether to another part of the town near the navvy works and making the forge more worthy of the volume of work which it has to handle.

The old iron foundry consists of three large shops on the corner of the Sheaf works, allocated to different classes of castings. There are two 10-ton cupolas and two with a capacity of 5 tons per hour. In the heavy foundry some very large work is carried out, an 80-ton casting for one of the drop-hammer bases in the forge having been produced there. The smaller cupolas are usually employed on castings of special white iron for malleable castings, of which the firm use great quantities in connection with their agricultural machinery. These castings are annealed in a separate building near the foundry containing muffle furnaces along both sides. The castings are packed in iron boxes filled with crushed hematite which remain in the furnaces for a week or two according to the nature of the work. The effect of course is to decarburise them to a greater or less extent, which makes them tough and malleable.

The forge and smith's shop adjoin the foundry, and are well equipped with steam hammers, drop stamps, &c., the latter ranging from 5 cwt. to 5 tons. These weights are exclusive of the dies, and as the upper die in the largest drop-stamp weighs itself about 2 tons, there is a total falling weight of about 7 tons on the piece being forged. Crankshafts and similar articles are made by these heavy stamps. Several of the steam hammers were made by Messrs. Ruston and Proctor themselves, and the same remark applies to numerous heavy punching and shearing machines in the works. Others are by Messrs. B. and S. Massey, Nasmyth, Wilson and Co., and other leading firms. An Ajax forging machine is installed for upsetting and flanging bars and similar work. Some of the furnaces are coal fired and others oil fired, and waste-heat boilers of Messrs. Ruston's own make are installed to utilise the heat in the flue-gases which would otherwise be lost. These boilers supply all the steam necessary for the steam hammers, but even then the heat is further utilised in a very interesting manner. The steam hammers do not exhaust to the atmosphere, but into a ring main which conducts their exhaust to an apparatus which has the external appearance of a surface condenser. This contains tubes through which the steam passes and gives up its heat to water surrounding them. The condenser works practically at atmospheric pressure, the air and non-condensible vapour being removed by a reciprocating pump. The circulating water is pumped from the shell of the condenser around heating pipes and radiators throughout the works from which it returns to the condenser. By this means the whole of the works can, under normal circumstances be heated indirectly by means of the residual waste heat of the forge. The advantages of using water heated by the exhaust steam itself in the heating pipes, rather than utilising the steam itself are that the body of water in the system adopted acts as a sort of thermal-storage to regulate the temperature, and also that the heating pipes are kept free from oil which would otherwise be carried into them by the exhaust steam and impair their efficiency. Provision is made for turning live steam into the water heater should the supply from the hammers be inadequate at any time.

The next large group of shops to be noticed are

the machine and engine erecting shops. The machine shops consist of nine bays covering an area of 94,000 sq. ft. and known as No. 1, 2 and 3 turneries. No. 1 turnery is the heavy machine shop where oil engine beds, cylinder heads, crankshafts and



INDEX TO FIG. 7.

No.	Description.
1.	Cost, general, manager and time offices.
1A.	Boiler and plant drawing offices.
2.	Weigh house.
3.	First aid dressing station.
4.	Smith shop.
4A.	Navvy stores.
4B.	Chain testing department.
5.	Navvy bay No. 1.
6.	Flanging and furnace work, bay No. 2.
7.	Plating and planing work, bay No. 3.
8.	Fitting work, bay No. 4.
8A.	Riveting work, do.
8B.	Riveting tower, do.
9.	Light plating and riveting, bay No. 5.
10.	Testing and light plating, bay No. 6.
11.	General stores.
11A.	Tool and machine shop.
11B.	Drawing stores and pattern shop.
12.	Latrines.
12A.	Electricians' department.
13.	Cycle store, workmen's.
13A.	Do. staff.
14.	Motor cycle shed.
15.	Carbide stores.
16.	Plate storage.
17.	Motor flanging shop.
18.	Storage rented from M. R. Co.
19.	Do. do. do.
20.	Do. do. do.

connecting rods are made. This heavy work is for the Ruston oil engines, as the steam engines built by the firm are generally of small kinds. During the war the Government required Messrs. Ruston and Hornsby to build a large number of multi-cylinder marine oil engines of the Diesel and other types which were made in this shop, the last going through at the time of our visit. The oil engine beds are machined by tools of the firm's own design, in which a facing head machines the cylinder jacket while a transverse boring bar at the same time bores and faces the two main bearings. The crank pins are turned on the largest size Gardner crankshaft lathe, and it is interesting to watch this machine finishing a pin with a forming tool the full length of the pin. The shop also contains some large plano-milling machines by Kendall and Gent, and a Churchill shaft grinding machine to finish shafts up to 16 ft. in length. The oil engine pistons are ground to size and the cylinder liners are reamed to a finish by means of inserted-cutter reaming heads on snout boring machines. A double-headed vertical machine by the Wilkinson Machine Tool Company, of Keighley, for boring out the large holes in the marine-ended connecting rods is also worthy of mention. The tools in this shop are for the most part of the usual type, jigs and fixtures being employed wherever possible to facilitate the machinery operations. One of the ingenious minor labour-saving devices is shown in Fig. 2, on page 5. This is a fixture designed to enable a thread to be cut on the end of crankshafts without the use of a screw-cutting lathe, so that the shafts may be finished completely on a plain turning lathe. The construction of the fixture is fairly evident from the illustration. A sleeve, carrying an external thread of the same pitch as the one to be cut, is bolted on to the shaft. A solid nut engages with this thread, the nut being held by a cast-iron bracket bolted for the purpose to the lathe saddle. The sleeve, therefore, acts as the lead screw of a screw-cutting lathe, and causes the saddle to travel so that the tool will cut a thread corresponding in pitch to that on the sleeve. The nut is prevented from rotating by a pair of flats upon it which are engaged by the sides of a slot in the carrying bracket. The slot permits of sufficient cross traverse of the screw-cutting tool for the required depth of thread, and at the same time allows the slide to be withdrawn from engagement with the nut on the completion of a traverse, so that the nut can be run back on the sleeve ready for the next cut.

Views of two of the erecting shops are given in Figs. 3 and 4, on Plate I. The first represents the normal condition of the road-roller shop, and gives a very good idea of the quantities in which machinery of this kind are manufactured by Messrs. Ruston and Hornsby. All parts are absolutely standardised and made for stock, so that erection becomes little more than the assembly of finished parts. Fig. 4 shows the oil engine erecting shop, and here again the illustration speaks for itself. This is a fine light shop and is well furnished with jib cranes on both sides so that the erectors can do much of their lifting and transporting without having to wait for the overhead traveller. The capacity of the shop is about 30 to 35 oil engines per week, of all sizes.

From the erecting shop the oil engines are taken to the oil-engine test beds, where they are all run on brake loads, indicator cards are taken and fuel consumption at various loads recorded. Water-cooled band brakes are used for the smaller engines, while the larger ones are usually coupled to Froude dynamometers, of which there are several available. There is also an experimental testing bay in which engines are subjected to protracted and elaborate

Fig. 8.

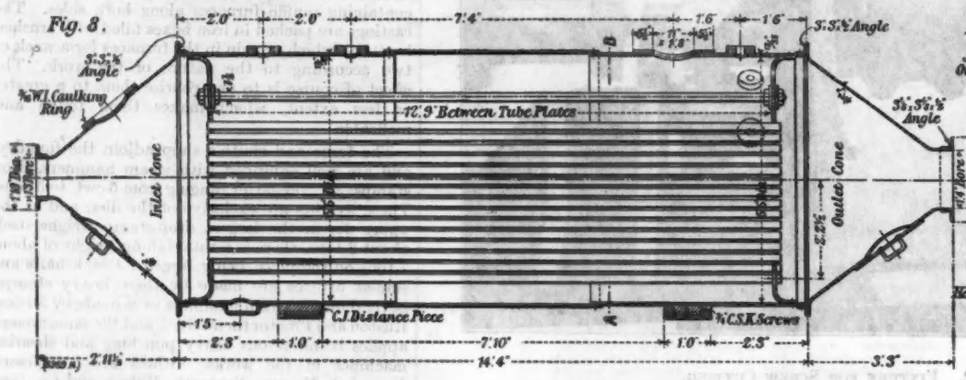


Fig. 9. SECTION ON LINE A.B

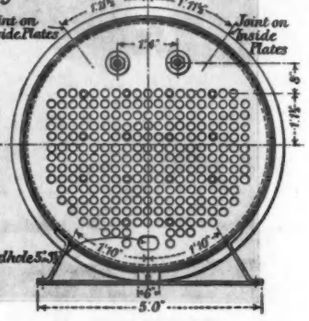
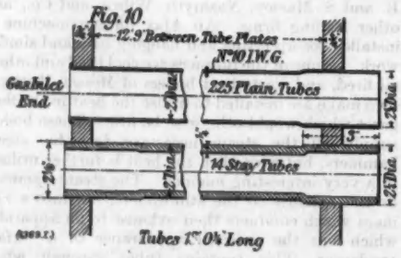


Fig. 10.



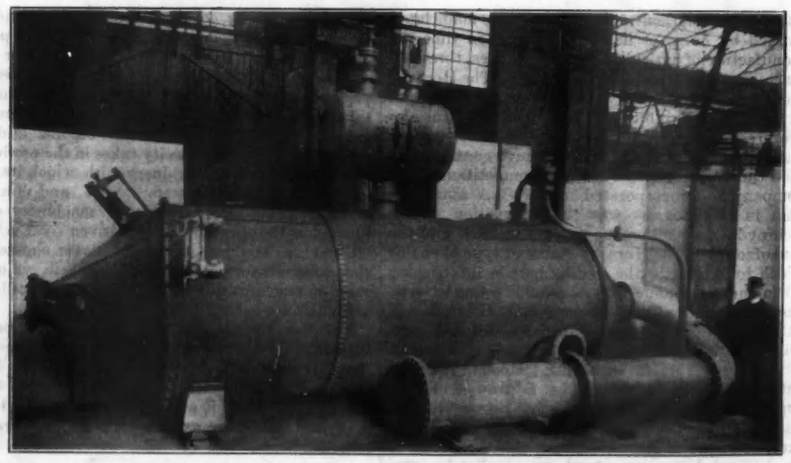


FIG. 11.

260-B.H.P. SOLID INJECTION CRUDE OIL ENGINE.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.

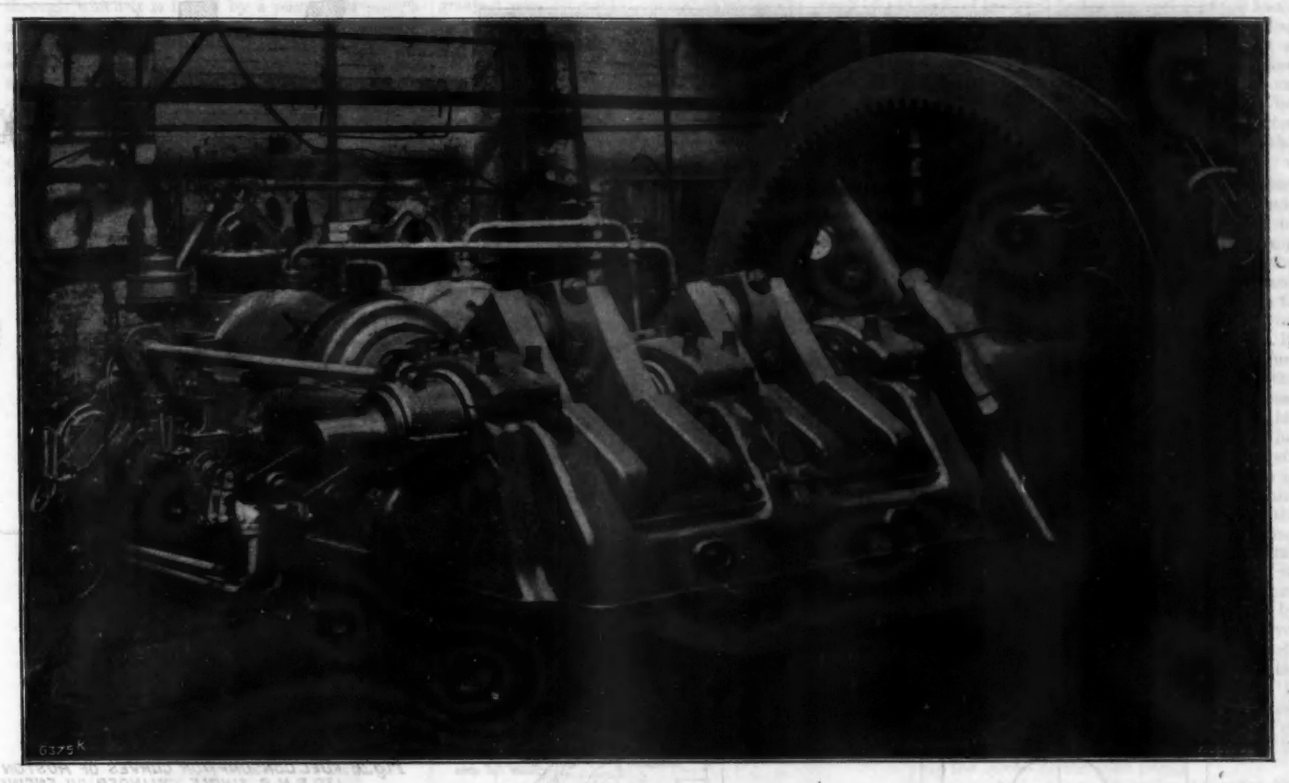


FIG. 12. 260-B.H.P. RUSTON CRUDE OIL ENGINE.

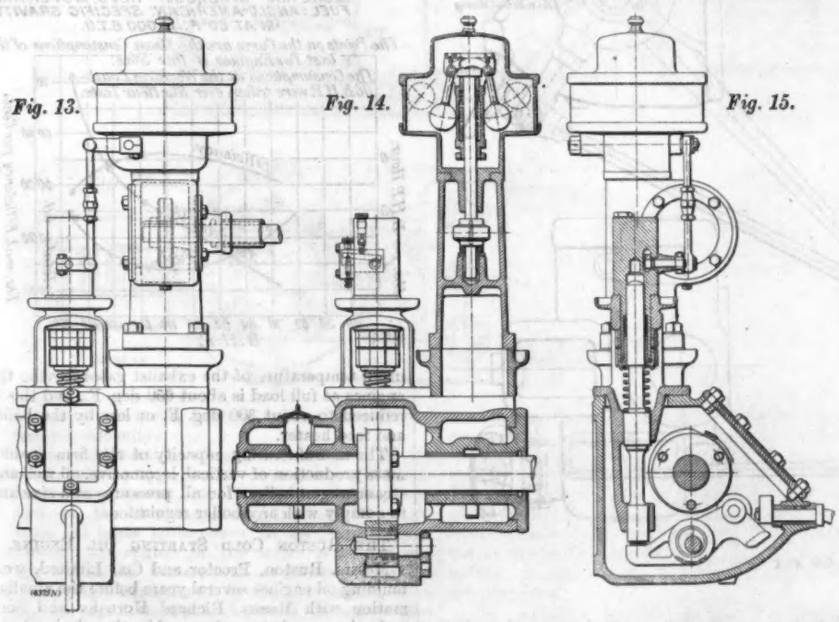


Fig. 13. *Fig. 14.* *Fig. 15.*

tests under special supervision whenever there is any need for such a course. Here every new type or size of engine undergoes exhaustive trials, and the effect of any proposed modification of the design of the standard engines is also carefully observed before commercial manufacture is commenced.

Comparative tests of different fuel oils are also carried out in this department. The thoroughness with which the testing of oil engines is carried out is illustrated by the fact that the aggregate area of the testing shops is no less than 18,000 sq. ft.

Fig. 5, Plate II, shows the interior of the new pattern shop. This shop is not, geographically speaking, a part of the Sheaf Iron Works but is situated on Spike Island near the new foundry, both departments having been forced to extend on a new site in consequence of the increase of the call upon their capacity.

THE BOILER WORKS.

The arrangement of the Boiler works is shown in Fig. 7, page 6, and a key to the plan is annexed to it. Almost every kind of boiler is made here from the small locomotive and other boilers for steam wagons to Lancashire boilers, 30 ft. by 9 ft. 6 in., and marine boilers, 10 ft. by 9 ft. 6 in. About 40 boilers of various kinds are turned out per week. During the war many Yarrow boilers for torpedo boats and twin-screw minesweepers were made here, and always there are waste heat boilers, vertical boilers, gas producers, rotary kilns, welded tanks and other examples of special boiler work in progress. The shops are well equipped for work of the largest size. A 600-ton Berry press provides for the flanging of plates up to 12 feet in diameter, and such plates when flanged can be turned and drilled without difficulty on special machines. A second hydraulic press of 500 tons, by Shaw and Sons, deals with smaller flanging and bending work. Hydraulic riveters up to 10 ft. 6 in. gap, by Messrs. Fielding and Platt and the Leeds Hydraulic Engineering Company, Limited, vertical bending rolls by Campbell and Hunter, large turning and drilling machines by Kendall and Gent, and numerous other tools are among the equipment of these works. Four gas furnaces working in conjunction with a Mond producer provide for the economical and convenient heating of the plates for flanging and pressing. The shop is well-equipped with oxy-acetylene and electric welding apparatus.

A view of one bay of the boiler works, showing many boilers in course of manufacture, particularly of the locomotive type for tractors, engines and road rollers, is shown in Fig. 6, Plate II.

The Ruston waste-heat boiler for internal-combustion engines is one of the specialities of these works. Figs. 8 to 11, page 6, illustrate sectional views of a boiler of this type suitable for working in conjunction with a gas or oil engine plant. The exhaust gases enter the boiler at the small end of a conical extension of the boiler drum, pass through a number of tubes surrounded by water and are led away to the exhaust pipe by means of an exit cone similar to that

260-B.H.P. SOLID INJECTION CRUDE OIL ENGINE.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.

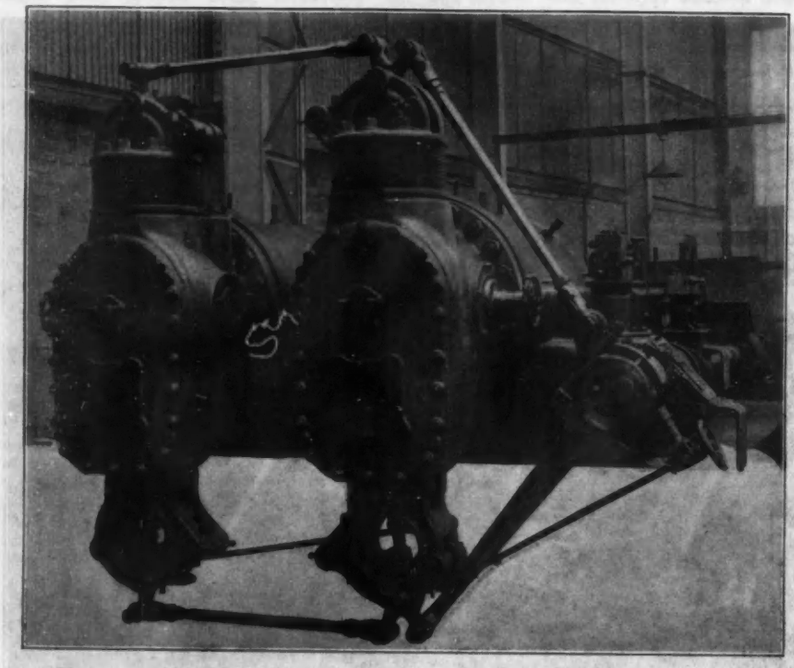


FIG. 16.

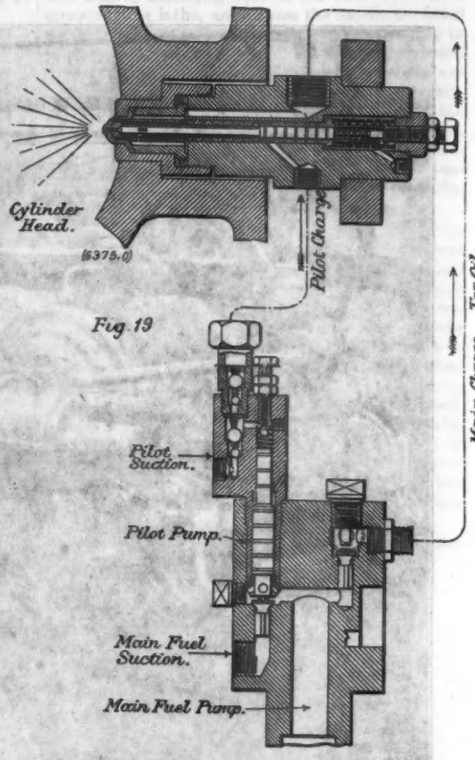
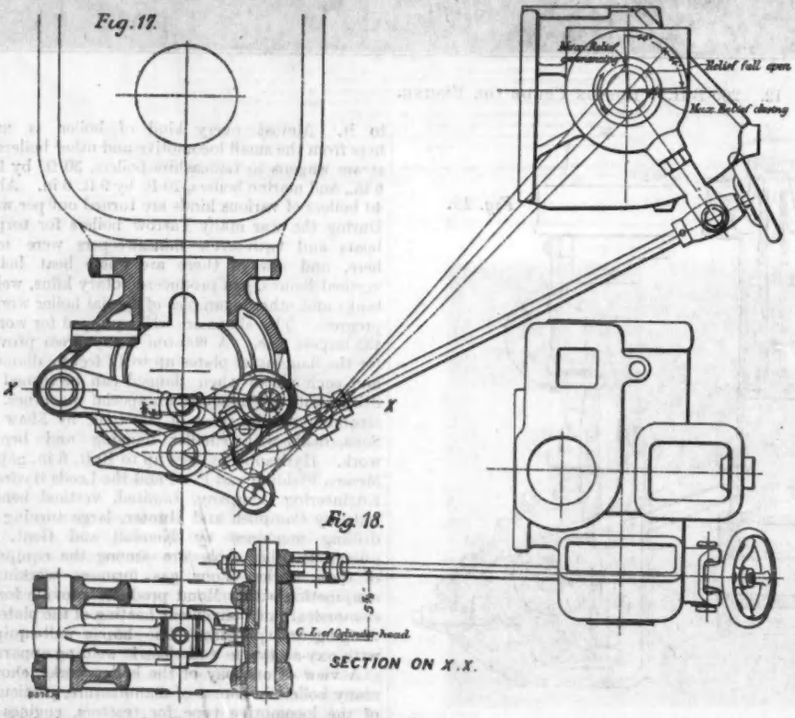


Fig. 19



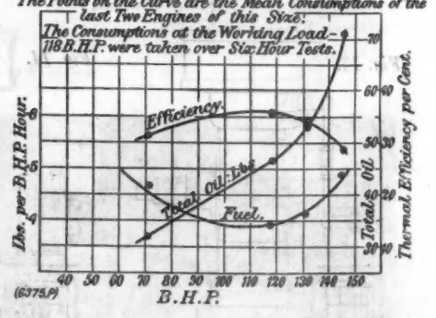


Fig 20. FUEL CONSUMPTION CURVES OF RUSTON 130 B.H.P. SINGLE CYLINDER OIL ENGINE.

BORE 18½" STROKE 30" REVS. 175 PER MIN. FUEL: ANGLO-AMERICAN: SPECIFIC GRAVITY ·91 AT 60°F: 18,000 B.T.U.

The Points on the Curve are the Mean Consumptions of the last Two Engines of this Size: The Consumptions at the Working Load—118 B.H.P. were taken over Six Hour Tests.

by which they entered. To secure further economy, however, and to provide feed water at a suitable temperature for the boiler, a feed heater is frequently fitted to work in conjunction with the latter. This consists of a water-jacketed pipe through which the gases pass on their exit from the boiler. Warm water from the cylinder jackets of the engine passes through the jacket of this pipe before entering the boiler, so that not only is the utmost amount of heat recovered from the exhaust gases, but the waste-heat boiler is fed with water at the highest possible temperature. A photograph of a waste-heat boiler complete with feed heater is shown in Fig. 11. This was built to work in conjunction with a four-cylinder gas engine of 500 brake horse-power and produced about 2¼ lb. of steam at 80 lb. pressure for every brake horse-power hour of the engine. Where steam or hot water is required for heating or process work, the Ruston waste heat boilers working in conjunction with internal combustion engines obviously offer great possibilities of economy, and act also as effective silencers to the engines. The usual temperature of the exhaust gases leaving the engines at full load is about 650 deg. F., and this is reduced to about 300 deg. F. or less by the boiler and feed heater.

The manufacturing capacity of the firm enables mass production of vertical, locomotive, oil well and steam wagon boilers for all pressures and size and to comply with any boiler regulations.

THE RUSTON COLD STARTING OIL ENGINE.

Messrs. Ruston, Proctor and Co., Limited, were building oil engines several years before the amalgamation with Messrs. Richard Hornsby and Sons took place, and since the combination the works at Lincoln and Grantham each continues to manufacture the types with which the firms have been respectively associated. The Ruston oil engine as developed in the year 1897 was of the well-known hot bulb type, but a new engine was exhibited at Nottingham in 1915 which will not only start directly from the cold state under all conditions, but which will use any kind of crude, residual or tar oil as fuel. This "cold-starting" engine, as it is called, works with a high com-

pression as, having no hot bulb it depends upon the heat of compression for the ignition of the charge. The latter is sprayed into the combustion space at the correct moment by means of a simple atomiser, through which it is forced by a pump, the complications and trouble arising from the use of high-pressure air for injecting the fuel being thus entirely avoided. Moreover, the "solid injection" system insures the accurate timing of the entrance of the charge and thus renders impossible the pre-ignitions which are liable to occur in engines which are dependent upon compressed air for the injection of the fuel. The high compression employed results in a very high efficiency so far as fuel consumption is concerned, figures below 0·4 lb. of fuel oil per

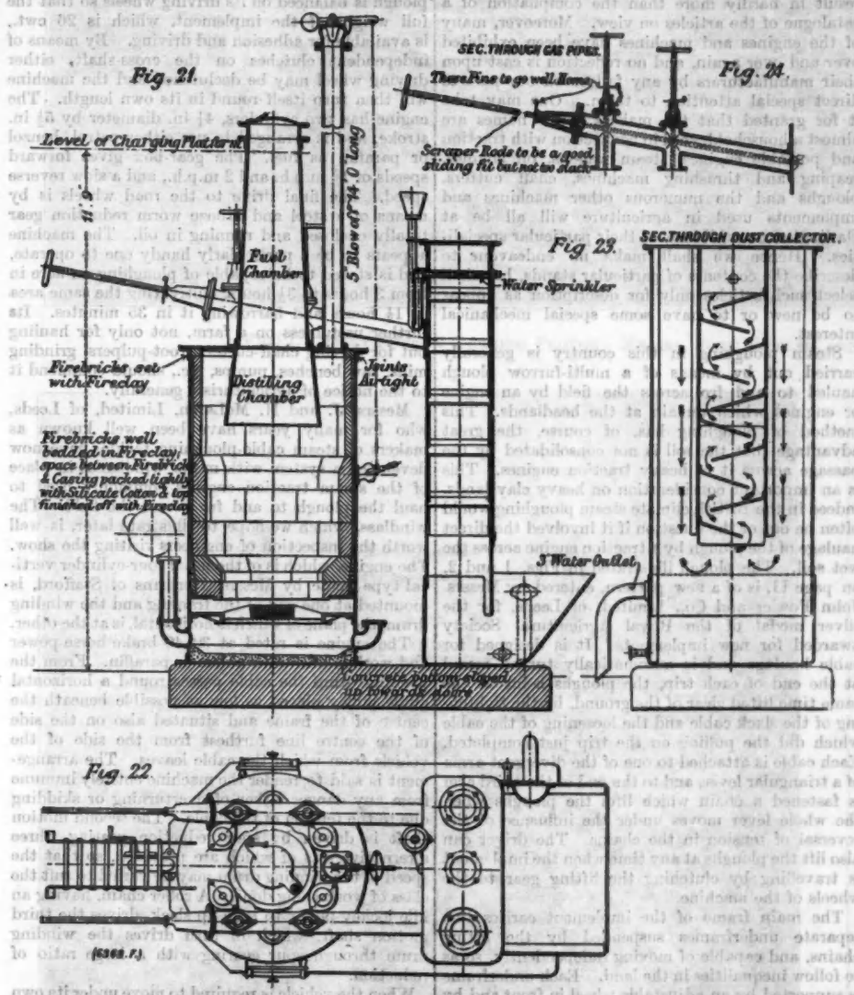


Fig. 21.
Level of Charging Platform
5' Bore & 4'-0" Long
Fuel Chamber
Firebricks set with Fireclay
Distilling Chamber
Joints Air-tight
Firebricks well bedded in Fireclay, space between Firebricks & Casing packed tightly with Silicate Cotton & top finished off with Fireclay
Concrete Foundation
Fig. 22.
(6368.F.)
SEC. THROUGH GAS PIPES.
Fig. 24.
Scraper-Rods to be a good sliding fit but not too slack
Fig. 23.
SEC. THROUGH DUST COLLECTOR.
Water Sprinkler
3" Water Outlet

brake horse-power, at full load, having been obtained without difficulty.

The cold-starting oil engines are built of the single-cylinder type in 11 sizes ranging from 15 brake horse-power to 170 brake horse-power, and of the double-cylinder type in five sizes, from 100 brake horse-power to 340 brake horse-power. An engine of the latter type, developing 260 brake horse-power, is illustrated in the photograph reproduced in Fig. 12, page 7, while Fig. 16, page 8, shows a back view of the same engine in course of erection. The fuel pumps and valve gear for both cylinders are driven from the single lay shaft running along the right-hand side of the engine, the eccentric operating the inlet and exhaust valves being keyed on the extreme end of this shaft. The motion of the eccentric is transmitted to the valves by means of rolling levers, shown more clearly in Figs. 17 and 18, on page 8, which give a more rapid opening and closing motion than could be obtained by the eccentric motion alone. The small hand wheel seen near the eccentric is for the purpose of relieving the compression by raising the exhaust valves slightly from their seats. This is only used when it is required to bar the engine round by hand for any purpose.

The cylinder heads have been designed with the greatest care to avoid strains which might result in cracked castings. The interior is entirely free from ribs connecting internal and external walls, thus permitting free circulation of the cooling water and avoiding the rigidity which so often leads to trouble with such castings. The hand wheels at the sides of the cylinder heads control the compressed air for starting, the one on one side of the head admitting air to the combustion chamber, and the one on the opposite side allowing the engine to recharge the air reservoir when running. It should be mentioned that the branches from the combustion chamber are only connected to the walls of the casting by means of sliding expansion joints, thus entirely avoiding any stresses due to temperature difference at this point. The large orifices in the lower portion of the cover plates are for the exhaust pipe connections, and the small facings on the horizontal centre lines are for the attachment of the atomisers. There is, of course, nothing in the nature of a hot bulb about the cylinder head.

The fuel pump for each cylinder is driven by a cam on the lay shaft. The governor is driven by an independent lay shaft and controls the speed of the engine by by-passing a greater or less amount of the fuel pumped per stroke, and so reducing the charge forced through the atomiser and burnt in the cylinder. The mechanism by which the by-passing is brought about consists of a small cam operated by the rise and fall of the governor, which acts upon a lever and controls the position of a by-pass valve situated in the pump body. The details of these parts are shown in Figs. 13, 14 and 15, page 7.

When working with the lowest grades of tar oil, it is necessary, in order to ensure proper ignition of the charge, to inject just ahead of the main charge a very small quantity of crude, or other more inflammable oil. This only amounts to about 5 per cent. of the total fuel consumption at full load. It is called the "pilot oil" and is forced to the atomiser independently of the main supply by a separate cam-driven pump. In Fig. 16 the pilot pumps for the two cylinders can be seen further from the back of the engine than the main pumps. The bent handles below each pair of pumps are for putting the pumps out of action, by raising the rollers clear of the cams.

Reference to Fig. 19 will make the construction of the atomiser and double-fuel pump evident. With this arrangement, which is usually fitted to engines designed to burn tar oil, a single main pump only is used. This pump primarily deals with the main supply of tar oil, but by a most ingenious arrangement the delivery of the tar oil is made to operate also a pilot pump which injects the lighter oil at the correct moment. On referring to Fig. 19 it will be seen that the main fuel pump takes in fuel through the main suction valve and delivers it to the atomiser through the discharge valve in the usual way. There is, of course, a by-pass valve on this circuit which is controlled by the governor, but this is not shown in the illustration. Above the main suction valve is the pilot pump, which consists of two plungers of different diameters, the lower and larger one being acted upon by the pressure of the main fuel. At every stroke of the main pump the upper and smaller plunger is raised against the action of a spring by the pressure of the fuel oil on the lower one. The upper plunger, therefore, acts as another pump on its own account, and by means of its own suction and discharge valves it forces the pilot oil to the atomiser separately from the main supply. It will be noticed that the pilot oil is necessarily injected immediately in advance of the main fuel oil, which is the required condition. Moreover, the amount of the pilot oil delivered at every stroke can be regulated by varying the stroke of the pilot pump.

The main fuel charge, in order to enter the cylinder, has to lift a hollow needle valve from a conical seating, when it can escape as a fine spray from a small hole in the nozzle of the atomiser. The barrel of the hollow needle valve has two different diameters, the enlarged portion acting as a piston and lifting the valve from its seat against the action of a spring by means of the oil pressure underneath it. A solid needle valve carried inside the main valve has also a pistonlike portion, and is held to its seating in the main valve by a spring. The pilot oil is led by means of ports to the underside of the piston of the solid needle valve. It lifts this piston by its pressure and escapes through the central hole of the atomiser independently of and fractionally in advance of the main fuel oil.

The curves reproduced in Fig. 20, page 8, show the actual performance of a modern Ruston oil engine, having a cylinder 18¼ in. diameter by 30 in. stroke, and developing 130 brake horse-power at a speed of 175 r.p.m. The points plotted represent the average of the performances of two consecutive engines of the type. In each case the test at 118 brake horse-power was of 6 hours' duration, the tests at the higher and lower loads lasting for 2 hours in both cases. The fuel used was Anglo-American fuel oil of specific gravity 0·91 at 60 deg. F. and of a calorific value of 18,000 British thermal units per pound. It will be seen that at the most economical load, the fuel consumption, as given by the curve, was only 0·39 lb. per brake horse-power hour, or, taking the actual test figures at 118 brake horse-power, it was only 0·395 lb. per brake horse-power hour over the equivalent of a 12-hours' run. The engines were naturally in first-class condition for the runs, but nevertheless the figures afford striking evidence as to what the best designers can now achieve in the way of fuel economy with an engine of a comparatively simple type, and without the complications of the Diesel.

Other products of the Ruston boiler works are gas producer plants for utilising all kinds of combustible refuse material for fuel in addition to those designed for the more usual coal and coke. Wood refuse from saw mills, match factories, &c.,

plum stones from jam factories, cocoanut shells, tan-yard waste and countless other materials the disposal of which is often a source of embarrassment or expense to their owners, may be converted into gas and thus utilised to supply power and heat at an extremely low cost. The gasifying of wood refuse is especially advantageous in works employing any considerable amount of wood-working machinery, as an effective horse-power hour or alternatively the equivalent amount of heat in the form of steam or of hot water may be obtained from about 3 lb. weight of ordinary wood refuse. Illustrations of a Ruston suction gas producer for wood refuse are given in Figs. 21 to 24, page 9. The producer itself is of the usual design. The gas passes from it by means of an inclined pipe in order that tarry matters passing over with the gas may drain back as far as possible to the producer rather than be carried over to the scrubber. The latter consists of a series of inclined baffle plates which intimately mix the gas with the descending shower of water. Poking holes in the producer top enable the fire to be attended to by means of the poking rods shown, and a similar rod provides for removing any tarry deposit which may collect in the gas ascension pipe.

(To be continued.)

THE ROYAL AGRICULTURAL SHOW AT DARLINGTON.

SINCE the year 1839, the Royal Agricultural Society has only failed to hold its annual show on three occasions, even the war suspending its activities in this respect for the years 1917 and 1918 only. Such a record marks the importance of its exhibitions not only to the agricultural community but also to that large branch of engineering industry which depends upon the needs of agriculture for its existence. The experiences of the last few years have brought home to the town-dwelling part of the population the elementary truth that their daily bread and meat, not to mention articles of clothing, are only available for them as a result of the efforts of the agriculturists, and they have come to realise in a way they never did before, that farming must be regarded as one of the leading industries of this country both in magnitude and importance. No organisation has done more for the benefit of British agriculture than the Royal Agricultural Society. The excellence of its literature on matters relating to agriculture is well known, and by its annual exhibitions it has been largely instrumental in securing and maintaining that pre-eminence for British live-stock which is admitted all over the world. These shows, however, are by no means confined to animals, for ever since the application of machinery to agriculture the Society has arranged for the exhibition of all kinds of machines devised to assist farmers either directly or indirectly. It has, in fact, done much more for the engineering industry than this, for by its scientifically and thoroughly conducted competitive trials of prime movers, tractors, ploughs, &c., it has procured for engineers reliable data of the most valuable nature. Some of the Society's trials have indeed become classic and its work in this connection might well be emulated by some of the organisations which are more specifically devoted to the furtherance of engineering knowledge.

The show last year was held in Cardiff, and although the entries on that occasion both of live-stock and machinery, were well in advance of the numbers recorded at Nottingham and Manchester during 1915 and 1916, they did not reach the totals attained for several years preceding the war. At Darlington, however, where the show for this year was opened last Tuesday, the pre-war figures have been largely exceeded. The live-stock entries, exluding poultry, rabbits and cavies, number 3,463, a record for the Society and a notable advance on the 2,502 animals entered at Cardiff last year. The last time the Society held its show at Darlington was in 1895, when the animals numbered only 1,703 head. It is, however, with the machinery and implements which we, as a journal, are directly concerned, and here also we note very substantial progress. At Darlington this year there are 471 machinery stands, occupying 14,494 sq. ft. of shedding exclusive of open yard space. Last year at Cardiff there were 371 stands occupying 11,209 sq. ft., while fifteen years ago the corresponding figures for Darlington were 393 and 12,597 ft. respectively. Thus it will be seen that the makers of agricultural and allied machinery, although by no means seeking much new work at the present time, have taken pains for their products to be adequately represented, and it is to be hoped that the attendance at the show will make it the success financially that its national importance deserves.

On account of the very large number of exhibitors at Darlington and of the magnitude and variety of the display made by so many of the leading manufacturers, any attempt to deal comprehensively with the exhibits in the space at our disposal would result in hardly more than the compilation of a catalogue of the articles on view. Moreover, many of the engines and machines have been exhibited over and over again, and no reflection is cast upon their manufacturers by any failure on our part to direct special attention to them. One may take it for granted that the makers whose names are almost a household word in connection with traction and portable engines, steam wagons, oil engines, reaping and thrashing machines, chaff cutters, ploughs and the numerous other machines and implements used in agriculture will all be at Darlington as exhibitors of their particular specialities. Hence we shall make no endeavour to describe the contents of particular stands, but shall select such articles only for description as appear to be new or to have some special mechanical interest.

Steam ploughing in this country is generally carried out by means of a multi-furrow plough hauled to and fro across the field by an engine or engines which remain at the headlands. This method of ploughing has, of course, the great advantage that the soil is not consolidated by the passage across it of heavy traction engines. This is an important consideration on heavy clay lands, indeed in the British climate steam ploughing would often be out of the question if it involved the direct haulage of the plough by a traction engine across the wet soil. The plough illustrated in Figs. 1 and 2, on page 11, is of a new pattern, entered by Messrs. John Fowler and Co., Limited, of Leeds, for the silver medal of the Royal Agricultural Society awarded for new implements. It is designed for cable haulage and is automatically turned round at the end of each trip, the ploughs being at the same time lifted clear of the ground, by the tightening of the slack cable and the loosening of the cable which did the pulling on the trip just completed. Each cable is attached to one of the divergent arms of a triangular lever, and to the end of the third arm is fastened a chain which lifts the ploughs when the whole lever moves under the influence of the reversal of tension in the chains. The driver can also lift the ploughs at any time when the implement is travelling by clutching the lifting gear to the wheels of the machine.

The main frame of the implement carries two separate underframes suspended by the lifting chains, and capable of moving independently, so as to follow inequalities in the land. Each underframe is supported by an adjustable wheel in front and by adjustable brackets behind, and is kept in track by vertical guides. The pull on the underframes is transmitted through the front guides. One underframe carries right-handed plough bodies and the other left-hand plough bodies, so that the earth is all turned inwards to a centre "fearing" as it is called in some part of the country. This fearing is made, as is usual in horse ploughing, on an original open furrow. In land previously ploughed in "stotches" the new open furrows will lie midway between the old ones. Accurate turning at the headlands is of course essential, and to ensure this an automatic ratchet gear comes into action and prevents any backward rotation of the wheel which is acting as a pivot for the implement to turn on. Each plough body is carried on an adjustable tyne and, of course, any desired types of coulter, share, sled or mouldboard may be fitted.

Messrs. John Fowler and Co., who have been so long identified with the manufacture of steam cable ploughs, are also exhibiting at Darlington a motor plough suitable for conditions when the use of their heavier tackle would be unjustified or impossible. Although designed primarily as a motor plough, the plough frame is made detachable so that a pair of wheels with steering gear can be substituted for it. The machine is thus converted into a useful little tractor suitable for pulling self-binders and other implements. It can also be adapted for cultivating, harrowing, &c., and when not required for any of the purposes mentioned, it can be employed as a power unit to drive stationary machinery. The machine equipped for ploughing is illustrated in Fig. 3, page 11. It will cut two furrows each from 8½ in. to 10 in. wide and from 5 in. to 6 in. deep, or if deeper work is required, it will cut a single 10-in. furrow 9 in. deep. The plough is balanced on its driving wheels so that the full weight of the implement, which is 26 cwt., is available for adhesion and driving. By means of independent clutches on the cross-shaft, either driving wheel may be declutched and the machine will then turn itself round in its own length. The engine has two cylinders, 4½ in. diameter by 5½ in. stroke, and is arranged to use either petrol, benzol or paraffin as fuel. The gear-box gives forward speeds of 1½ m.p.h. and 2 m.p.h., and a slow reverse speed. The final drive to the road wheels is by means of a steel and bronze worm reduction gear totally enclosed and running in oil. The machine appears to be a particularly handy one to operate, and is stated to be capable of ploughing an acre in from 3 hours to 3½ hours, cultivating the same area in 1½ hours and harrowing it in 35 minutes. Its further usefulness on a farm, not only for hauling but for driving chaff-cutters, root-pulpers, grinding mills, saw benches, pumps, &c., should commend it to the notice of agriculturists generally.

Messrs. J. and H. McLaren, Limited, of Leeds, who for many years have been well known as makers of steam cable-ploughing tackle, have now developed a system with motor windlasses in place of the steam traction engines commonly used to haul the plough to and fro across the field. The windlass, which we hope to illustrate later, is well worth the inspection of engineers visiting the show. The engine, which is of the usual four-cylinder vertical type made by Messrs. Dormans of Stafford, is mounted at one end of the framing and the winding drum, the plane of which is horizontal, is at the other.

The engine is rated at 30–40 brake horse-power and works either with petrol or paraffin. From the winding drum the cable passes round a horizontal guide pulley placed as low as possible beneath the centre of the frame and situated also on the side of the centre line furthest from the side of the vehicle from which the cable leaves. The arrangement is said to render the machine entirely immune from any danger either of overturning or skidding due to the tension of the cable. The second motion shaft is driven by spur reduction gearing, three alternative sets of which are provided, so that the speed of the winding drum may be varied to suit the class of work being done. A roller chain, having an idle jockey pulley to take up slack, drives the third motion shaft, which in turn drives the winding drum through spur gearing with a large ratio of reduction.

When the vehicle is required to move under its own power, or to act as a tractor, the third motion shaft is thrown out of gear with the winding drum and in gear, through bevels, with a vertical shaft which drives the axle of the road wheels. This last drive is by means of worm gear, the worm wheel containing the necessary differential gear. Reversing is effected by means of a second bevel on the third motion shaft which engages with the opposite side of the vertical bevel wheel, the forward-driving bevel being of course then disengaged. Mechanically, the whole of the design is simple and strong.

The machine weighs 3 tons 5 cwt. in working order and pulls a four-furrow plough at a speed of 3 to 4 miles per hour, depending upon the nature of the ground and the gearing in use. A complete ploughing set comprises a pair of windlasses, one at each side of the field. Each hauls the plough alternately and when one is hauling the other is paying out. The idle engine is stopped when paying out and the drum is braked to prevent it overrunning. Just at the end of the paying out process, the driver puts in a clutch which temporarily connects the engine shaft with the drum through a pitch chain

EXHIBITS AT THE ROYAL AGRICULTURAL SHOW AT DARLINGTON.

FIG. 1. EIGHT-FURROW TURNING PLOUGH; MESSRS. JOHN FOWLER AND CO., LTD., LEEDS.

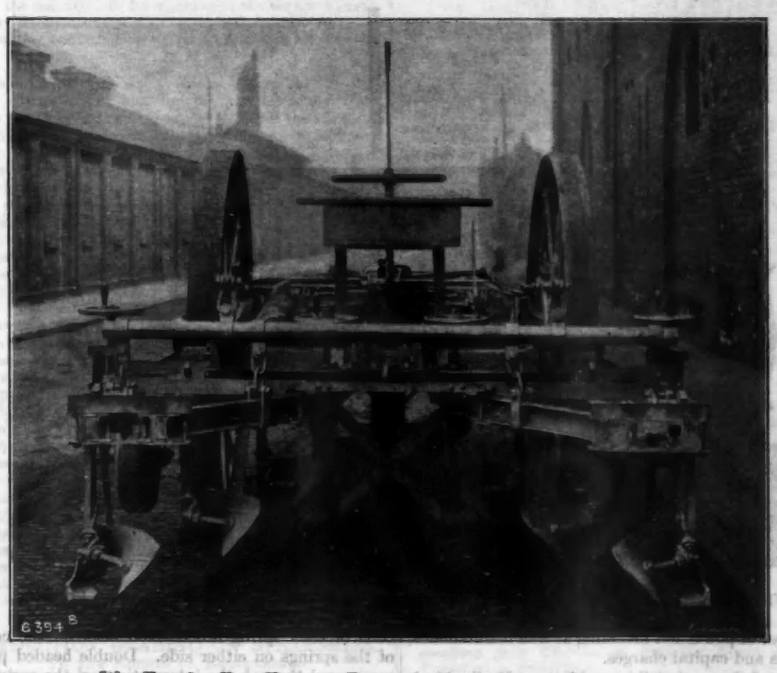


FIG. 2. END VIEW OF FOWLER'S EIGHT-FURROW PLOUGH.

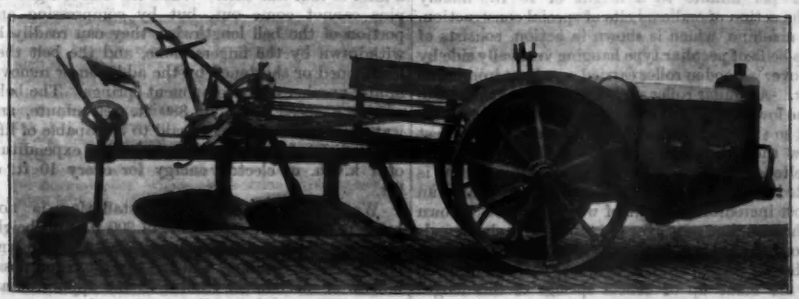


FIG. 3. COMBINED MOTOR PLOUGH AND TRACTOR; MESSRS. JOHN FOWLER AND CO., LTD., LEEDS.

and sprocket gear, thus causing his engine to turn round and restart with the greatest ease.

The plough used in conjunction with the motor windlasses is of the anti-balance type in which a long frame which can rock about its centre carries two sets of oppositely-faced ploughs, one set to be used for each direction of traverse. The centre of the plough body is not fixed to the axle of the two travelling wheels, but is formed with an obtuse re-entrant angle. When neither end of the plough is working the frame is supported in the angle and being practically in balance, either end can be raised or lowered with ease. When, however, the tension of the cable acts on the body in either direction, the body travels forward relatively to the central axle and is then supported at some little distance from the apex of the obtuse angle. In this position it is out of balance by an amount sufficient to keep the working shares at the required depth in the ground. The frame can be locked centrally in its balanced position for travelling along the road.

A plough designed by Messrs. Ruston and Hornsby Limited, of Lincoln, for tractor haulage, is illustrated in Fig. 4, on page 12. It is primarily a two-furrow plough, but is easily convertible into a three-furrow implement when the cutting of three furrows is within the power of the tractor. A special feature is the ease with which the ploughs' bodies can be lifted by means of a cord from the tractor driver's seat. The bodies are of malleable iron, and can be adjusted to cut furrows from 8 in. to 10 in. wide for general-purpose work, or up to 12 in. wide for digging. For the former work swivelling disc coulters are the standard fitting, but skim coulters are used for digging. The furrow wheel, which is 3½ in. wide, is of wrought iron throughout and is fitted with dustproof caps. Another feature of the design is that the rigid drawbar enables the plough to be backed by the tractor for manœuvring purposes.

The Ancona Motor Company, Limited, of 78-82, Brompton-road, London, S.W. 3, are exhibiting the British Wallis motor tractor, manufactured to an American design by Messrs. Ruston and Hornsby, Limited, of Lincoln. Reference to this tractor is made in the description of the works of this firm which we are now publishing. The appearance of the machine is shown on Fig. 5, page 12. It has an engine with four cylinders 4¼ in. diameter by 5½ in. stroke cast en bloc and runs normally at 850 r.p.m. The wheel base is 7 ft., the overall length 11 ft. and the greatest width 5 ft. 1 in. It weighs in running order 8,360 lbs., and dynamometer records taken during some recent ploughing

EXHIBITS AT THE ROYAL AGRICULTURAL SHOW AT DARLINGTON.

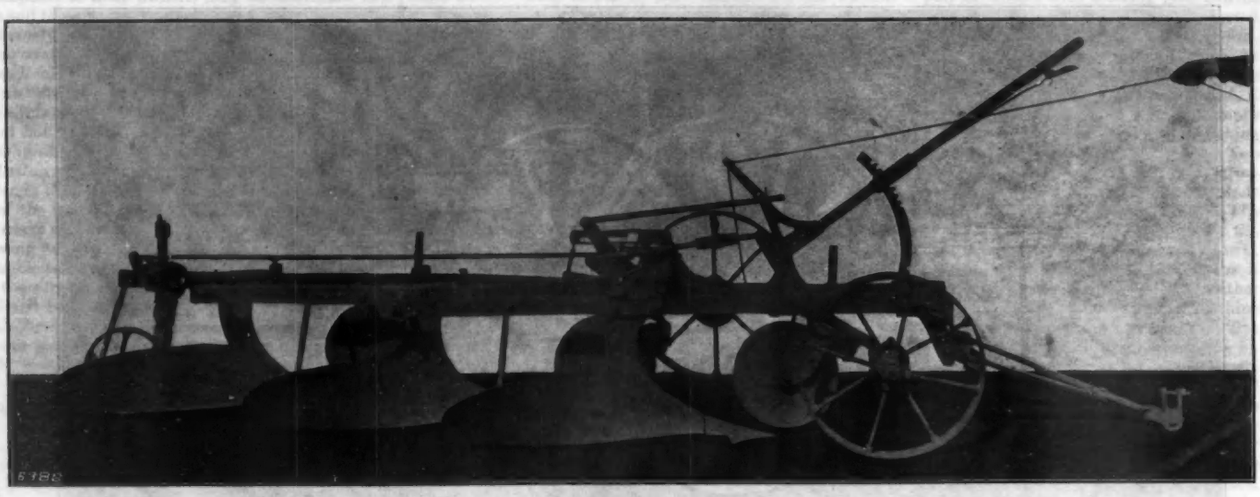


FIG. 4.—PLOUGH FOR TRACTOR HAULAGE; MESSRS. RUSTON AND HORNSBY, LTD., LINCOLN.

operations in Regent's Park showed a mean drawbar pull of 2,700 lbs. at 2 miles per hour and 2,350 lbs. at 2·3 miles per hour. This is sufficient to pull a 10-in. or 12-in. three-furrow plough on most soils. On high speed the machine will travel at from 3½ to 4 miles per hour at which speed it will exert sufficient tractive force for hauling a self-binder, harrowing, sowing, &c. The driving wheels are 48 in. diameter by 12 in. face, and the machine will turn within a radius of 7 ft. The engine starts on petrol and runs on paraffin, using a Halliday carburettor. The fuel in this is fed through a jet flush with the throat of a choke tube, and surrounding the latter are a series of annular passages through which the incoming air passes. The idea of this is to keep the fuel from contact with the surrounding metal until it reaches the vaporiser. This latter consists of a horizontal pipe jacketted by the exhaust gases and traversed by a large number of small cross-tubes through which the hot gases also pass. An extra-air supply picks up water from a jet in another choke tube, and carries the water-vapour by an independent pipe to the induction pipe on the engine side of the vapouriser. The tractor when used as a stationary engine is fitted with a belt-pulley 18 in. diameter by 6 in. face running at 430 revolutions, and will develop 25 brake horse-power on the belt.

Messrs. Richard Garrett and Sons, Limited, Leiston, Suffolk, are showing the chassis of an electric lorry of their own design which they have recently put upon the market after a lengthy period of experiment. It is intended especially for urban traffic and is built to carry a net load of 2½ tons. The power is supplied by an 80-volt "Iron Exide" battery, of a capacity of 226 ampere hours at a 5-hour rating. The chassis, complete with battery and body, ready for the road, weighs 3 tons. The vehicle has a single compound wound motor driving a cross shaft through differential gear, and from each end of the cross shaft the power is transmitted to the corresponding road-wheels by means of a roller chain. The mechanism is thus of the greatest possible simplicity. Ball or roller bearings are fitted throughout. The normal speed on the level is from 11 to 12 m.p.h., but the electric controller provides altogether three forward speeds and two reverse. Both foot and side brakes are provided and these are so interlocked with the controller that it is mechanically impossible for either brake to be on unless the current is off. Thus the motor is safeguarded from abuse or accident. The vehicle, of course, has rubber tyres and the battery is guaranteed by the makers for two years. It is claimed that when working on good roads, electric vehicles of this type provide the cheapest form of commercial transport, taking into account not only the cost of power but including as well maintenance, repairs and capital charges.

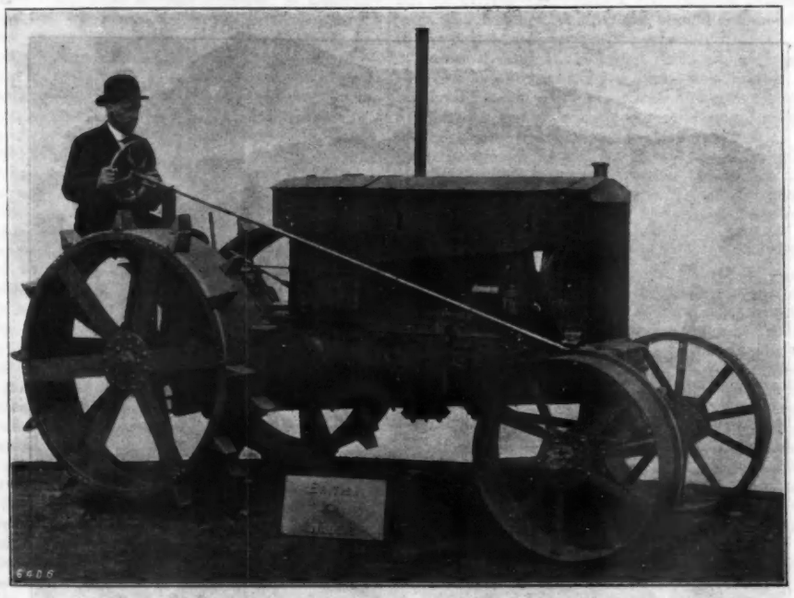


FIG. 5. THE BRITISH-WALLIS MOTOR TRACTOR; THE ANCONA MOTOR CO., LTD., LONDON.

One of the most striking exhibits at Darlington is a chain-belt water-lifter capable of lifting 5 tons of water per minute to a height of 10 ft., merely by the action of endless belts of special construction. The machine, which is shown in action, consists of three belts of peculiar type hanging vertically side by side over a wooden roller carried on a light iron frame work. A similar roller, unattached to anything, lies in the lower loop of the belts, which hang in a water-tank so that the lower roller is submerged a few feet below the surface of the water. The upper roller is belted to a 9 h.p. motor. When this motor is started the belts, of course, revolve and raise an almost incredible amount of water which is thrown off them as they pass over the top roller and descends in torrents in the most spectacular manner from the height of 10 ft. The belts are each 12 in. wide and are made up of helical springs of this length and about 1½ in. diameter wound alternately right and left-handed. These are laid side by side, transversely across the direction of the belt, and the coils of each spring are entered between the coils of the springs on either side. Double headed pins are passed through the intersections of the springs, locking them together, so that the whole make up a kind of mat-like belt. When the belt is tight the pins cannot come out, but by compressing any portion of the bell lengthwise, they can readily be withdrawn by the fingers alone, and the belt then lengthened or shortened by the addition or removal of any number of its component springs. The belts run at a speed of about 880 ft. per minute, and water-lifts of this type are said to be capable of lifting 50 tons of water per hour for the expenditure of 1 k.w.h. of electric energy for every 10 ft. of lift.

We understand that an installation is now being put down for a total lift of 200 ft., this height being attained in three stages. The extreme simplicity, the portability, and the freedom from possibilities of mechanical trouble of the apparatus are very striking, while its efficiency is not by any means bad in view of its other advantages.

(To be continued.)

NOTES ON NEW BOOKS.

THE designing of grooved rolls for the rolling of rails, channels, tees and other sections forms the subject of a book, or album, entitled "*Walzenkalibrierungen*," by the late Mr. J. Dehez, Duisburg, issued by the Verlag Stahleisen, Düsseldorf, who quote for it the price of 1*l.* 16*s.*—in British currency. It gives in full-scale size the shapes which the ingot undergoes in the rolling process at the various passes until the finished rail is obtained, in the case of various flange rails, a double-headed rail and tramway rails, these being accompanied by diagrams and tables of linear measurements of the rolled product at each pass, and by tracings on a reduced scale of the grooves in the rolls for the different passes. Information of the same nature is given in the case of channels of different sections, special guard rails, tees of ordinary and special shapes, angles, angle-shaped sleeper rails, and various other special sections and sleepers.

We have received from the publisher, Mr. Jules Rey, Grenoble, two books in the French language, one by Mr. Girardet, "*Lignes Electriques Aëriennes*," price 12 francs; the other by Messrs. J. Pionchon, Th. Heilmann and R. Valensi, "*Guide Pratique pour le Calcul des Lignes Electriques Aëriennes et des Pylônes Métalliques*," price 9 francs. Both deal extensively with the establishment of aerial electric mains, the constitution of these, their supports (the first book giving the advantage to poles made of reinforced concrete), &c., full particulars being added, also in the first book, of the French legislation governing work of this nature. The second book contains technical data, tables and diagrams for the calculation of aërial mains for alternating and three-phase currents. It states several problems dealing with lines to be established under given conditions and for given purposes, and adds the calculations for arriving at the required result. Both publications together or separately form an interesting contribution to the literature on the subject.

Technical text books, or books of formulæ, by their very nature are at best but dry publications: since, however, they meet their purpose, which is the affording, when carefully indexed, of a rapid means of reference, there is nothing to say against their form. They are, however, generally comparable to a dictionary which merely gives the words of one's own language translated into one or several words of the foreign language with which it deals. This suffices to an expert who has sufficient knowledge of the foreign language in question to select the right one among the words the dictionary offers him. Other dictionaries of foreign languages state in addition a number of examples, and owing to this they have a much wider range of usefulness. "*Cassell's Engineers' Handbook*," Part I of which we have received, may be compared to the latter set of dictionaries. The work is by Professor Harry Adams, M.Inst.C.E., M.I.Mech.E., &c., and is announced to comprise facts and formulæ, principles and practice in all branches of engineering. It measures 9¼ in. by 6¼ in., and is to be completed in 16 fortnightly parts, at the price of 1*s.* net each. The first issue contains 48 pages of explanations of numerous technical terms, the enumeration of various laws, principles and theorems and fundamental principles of mechanics. Judging from this first issue, the work will form a valuable compendium for practical engineers, and an interesting guide to which they will find reference easy when they wish to refresh their memory on any basic point. Students also will greatly appreciate its contents.

"REDUCTION GEARING ON STEAMSHIPS."

TO THE EDITOR OF ENGINEERING.

SIR,—An article which appeared on the above subject in your issue of May 7 suggests that the troubles which have been experienced on certain designs of double reduction gearing arise from the inertia forces on the gear teeth following the separation of the gear teeth resulting from large variations in propeller torque.

A graph from a recording torsionmeter was shown in which the minimum value of the torque was zero and the maximum 75 per cent. greater than the mean.

Under such conditions, it is conceivable that separation of the teeth may follow, but our experience does not suggest that variations in torque of anything like these values can arise at the gears except where the variations in torque at the propeller are augmented by the system running at, or close to, its torsional frequency of vibration. In the normal case, where the torsional frequency of vibration is much below the normal speed, the elasticity of the long shaft between the propeller and the gears decreases, at the gears, the magnitude of the torque variations arising at the propeller.

In support of his suggestion your contributor points to the more uniformly satisfactory experience enjoyed with single reduction, and implies that as the kinetic energy, or flywheel effect, of the slow speed line in this case is usually greater than that in the case of the double-reduction gear, the increase in pressure on the teeth resulting from variations in propeller torque will be less in the former case than the latter. Further, he suggests that conditions on a double-reduction geared set can be improved by the addition of a flywheel between the slow-speed wheel and the propeller.

Even assuming that tooth separation does arise from variations in propeller torque, it seems very doubtful to us whether the addition of such a flywheel will not increase the percentage increase in pressure arising on the teeth when separation takes place. If tooth separation does not take place from variations in propeller torque, and our information suggests it does not, it is of interest to compare the changes in factor of safety on the tooth surface of single and double-reduction gears which accompany variations in angular velocity of the system arising from the propeller.

The inertia forces accompanying variation in angular velocity of the propeller which arise at the teeth of a pinion depend not only upon the flywheel effect of the slow-speed wheelshaft and propeller, but also upon the flywheel effect of the rotating masses on the driving side of the pinion.

Now, while the polar moment of inertia of the slow-speed wheel of a single-reduction gear may be greater than that of the corresponding wheel of a double-reduction gear for a duplicate ship, the polar moment of inertia of the rotating masses coupled to the single-reduction pinion is also greater.

Table I gives the ratio of the polar moments of inertia of turbines for the same output and steam conditions for both double and single-reduction gearing. The turbine in the latter case will not be as efficient as in the former, because it is not commercially possible to design its blading for a higher value of the ratio of the mean speed of the blades to that of the steam leaving the stationary element $\left(\text{ratio } \frac{U}{C_o}\right)$.

In the table, values for the ratio of the moments of inertia of the single-reduction turbine rotors are given for velocity ratios of 90 per cent. and 80 per cent. of that adopted in the case of the turbines for the double-reduction gear. The average case in practice varies between these limits.

The ratios of the moments of inertia and stored kinetic energy (flywheel effect) of the elements of the double and single-reduction gearing, which we would design if we considered duplicate propositions for the same ship, is given in Table II. It may be desirable to state that these figures are not based upon imaginary cases, but are taken from actual designs. In designing the three gears the same pressure constants were employed, and the design of both was normal, being in line with the methods we have adopted from the time of the first double-reduction gear. The single-reduction gear proposition indexed A, runs at the same propeller speed as the double-reduction proposition, while that indexed B runs at a higher propeller speed.

The relative percentage increase in pressure on the teeth of the pinions arising from variations in angular velocity of the propeller or momentary variations in propeller torque are given in the last two columns, Table III, together with an indication of the steps by which it can be evaluated.

It is not quite certain as to which of the two last columns of figures should be taken as forming a comparison of the inertias of the two systems. Taking the last column, which is the least favourable to the double-reduction gear, the single-reduction gear indexed A is 1 per cent. worse off than the double-reduction gear, while that indexed B is 4·5 per cent. better. That is, there is no advantage in this respect in favour of single-reduction gearing.

As your contributor suggests, it is probable that the permissible pressure on the teeth of the pinion varies at some higher rate than the square root of its diameter. If this is so, it should be remembered that as the double and single-reduction gears which have just been examined have been dimensioned with the pressure varying as the square root of the pinion diameter, the second reduction of the double-reduction gear has a higher factor of safety than that of the single-reduction gear.

Yours faithfully,

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED.

(H. L. GUY, Chief Turbine Engineer.)

[If we understand our correspondent correctly, he assumes that excessive wear of gear teeth is due to static pressures. In our opinion it is dynamic action which is responsible for the failure of gear teeth in service. Owing to the existence of the oil film, opposing teeth never come into physical contact, and owing to dynamic action the thickness of this film is constantly varying. If these variations exceed certain limits, theory shows that extraordinarily high pressures will be set up within the film, although the average pressure throughout a cycle may not be at all high. These "dynamic" pressures may be due to badly-cut teeth; or to lack of alignment in the gears, but will also arise from cyclical variations in the propeller torque. Mr. Emmet declares that the extraordinary variations in propeller torque, shown in the diagram referred to by our correspondent, were observed with thoroughly trustworthy apparatus, but it is undoubtedly true that a very much smaller range of variation may give rise to serious wear of gear teeth. One firm with special experience in these matters specify that the torque variation of air compressors to be driven by de Laval gearing shall not exceed 7 per cent. Obviously the greater the flywheel effect of the propeller shaft and wheel as compared with the flywheel effect of the turbine motor and intermediate gears, the less serious will be the effect of propeller torque variations.

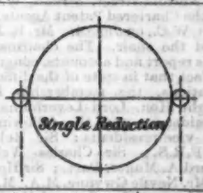
Unfortunately our correspondent has omitted from Table III data as to kinetic energy of the intermediate wheels and gear. In one case, however, in which we have been able to get comparative figures for corresponding double and single reduction gears, the ratio of the flywheel effect of the turbine rotor, pinions and intermediate gears to the flywheel effect of the propeller

TABLE I.—*Ratios of Polar Moments of Inertia of Turbines for Double and Single-Reduction Geared Ships.*

Type.	Turbine Speed. R.P.M.	$\frac{U}{C_o}$	No. of Stages.	Mean Diameter of Stages.	Polar Moment of Inertia of Turbine Rotor.	Kinetic Energy of Turbine Rotor.
Double Reduction	1·0	1·0	1·0	1·0	1·0	1·0
Single Reduction	0·5	0·9	1·0	1·8	10·5	2·625
	0·5	0·9	0·81	2·0	16·0	3·2
	0·5	0·8	1·0	1·6	6·55	1·64
	0·5	0·8	0·64	2·0	16·0	2·56

TABLE II.—*Ratios of Moments of Inertia, Speeds and Flywheel Effects of the Component Elements of an Alternative Double and Single-Reduction Gear for a Definite Ship.*

—	High-Pressure Turbine and Pinion.	Intermediate Wheel and Pinion.	Slow Speed Wheel, Shaft and Propeller.	Intermediate Wheel and Pinion.	Low-Pressure Turbine and Pinion.	Total.
Polar moment of inertia ..	0·00583	0·0728	0·8413	0·0728	0·00728	1·00
Speed of rotation	35·3	4·71	1·00	4·71	35·3	—
Kinetic energy	0·346	0·088	0·046	0·088	0·432	1·00



—	Symbol.	High-Pressure Turbine and Pinion.	Slow Speed Wheel, Shaft and Propeller.	Low-Pressure Turbine and Pinion.	Total.
Polar Moment of inertia	A	0·053	1·982	0·051	2·086
	B	0·034	1·86	0·033	1·93
Speed of rotation	A	17·45	1·00	17·45	—
	B	18·82	1·118	18·82	—
Kinetic energy ..	A	0·877	0·070	0·842	1·789
	B	0·657	0·129	0·634	1·42

TABLE III.—*Ratios of Increase in Pressure per Inch Width of Pinion of Double and Single-Reduction Gears resulting from Changes in Propeller Speed due to Variation in Resistance.*

—	Symbol.	Pitch Speed Ratio.	Ratio of Total Tangential Pressure on Pinion Teeth.	Ratio of Work on Pinion for 1 per Cent. Reduction in Speed caused by Propeller.	Ratio of Change in Pressure on Pinion Teeth for 1 per Cent. Reduction in Speed.	Ratio of Per Cent. Change in Pressure on Pinion for 1 per Cent. Change in Speed.	Percentage Change in Pressure on Teeth for 1 per Cent. Change in Torque.
Intermediate pinion of D.R. gear		1·00	1·00	1·00	1·00	1·00	1·00
Pinion of S.R. gear	A	1·499	0·667	1·817	1·212	1·817	1·01
	B	1·671	0·598	1·355	0·81	1·354	0·955

shaft and its gear was 20 for the double reduction gears and 10 for single reduction gears. Hence the latter should be much less sensitive than its rival to variations in propeller torque.—ED. E.]

"LABOUR DIFFICULTIES AND SUGGESTED SOLUTIONS."

TO THE EDITOR OF ENGINEERING.

SIR,—Reading your review of Mr. Deeley's book in your issue of June 11, it seems to me that the author, along with the many others who have recently written on "Reconstruction," &c., overlooks the real difficulty. A similar state of things occurred after the war with Napoleon. There was a great increase in the National Debt and in the revenue and a great increase in prices. These things produced evil effects then as now, and the effects remained till, by the increased use of machinery, the individual output rose by an equivalent amount. No doubt the same thing will recur, and we are all agreed that increased output is the only permanent remedy. Its advocates, however, do not seem to understand that appeals to the workman are useless because the increase required is far beyond that obtainable by merely working harder.

By careful choosing of men, adoption of labour-saving devices and thorough supervision an increase of 30 per cent. to 35 per cent. above pre-war output *might* be reached; but to do any good a permanent all-round increase of at least 100 per cent. on pre-war output is needed. That is, the output must be doubled, and this must be done not only by a few high-class shops but by the whole agricultural and manufacturing industry of the country.

Such an increase as this will not be reached by merely improving the relations between employers and employed or the training of foremen. Still less by Works Committees or Whitley Councils. All these things have their uses no doubt but for increasing output they are manifestly absurd. A thorough reorganisation of the whole business of production and distribution is required, but unfortunately any move in this direction appears very difficult. Obviously the first step should be the fusion of small scattered firms wherever possible into a single large business. Any combination of firms, however, is greeted by the daily press as a "trust" or "ring." I regret to say, only too often with reason, our recent experience of Government control over housing, collieries and railways is worthy of the worst traditions of the eighteenth century.

Yours faithfully,
W. H. LATHAM.

SPRINGS OF MOTOR VEHICLES.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the interesting article in your issue of June 11th, by Mr. F. Strickland, on "Defects in Motor Vehicles and their Remedy," and his remarks on springs, it would be very useful information for the designers and manufacturers of motor vehicle springs if Mr. Strickland could give the physical properties (in the hardened and tempered condition) and chemical analyses of the steel in the springs referred to in his Tables I and II, or if he has not got these details would he state what he considers they should be in springs designed for a stress of 45,000 lb. under static load and 90,000 lb. under full deflection as he suggests?

Yours faithfully,
J. S. G.

Woodside, 92, Wake Green-road, Moseley, near Birmingham, June 23, 1920.

[We forwarded a proof of the above letter to the author of the article referred to, and he has sent the following note on the matter: "I regret that I cannot give the particulars of the steel used in the springs. The suggested stresses are, of course, only an approximation and are intended for springs made of commercial spring steel. If special qualities of steel were used which were found to be capable in practice of working safely at higher stresses than ordinary spring steel the design could be modified accordingly. The essential object of the article was to point out the very high stresses that springs are expected to work at and the great inconsistency in proportions; also to give an indication of the principles to be followed to reduce the stresses and consequently the breakage. Since writing the article I have had an opportunity of examining the springs of the Liberty truck, which was designed by a committee representing the best motor experts of the United States of America. These follow the lines suggested in my article, i.e., they are broad springs with many thin leaves. Front springs 3 in. broad, 10 leaves, back 4 in. wide, 17 leaves. The maximum stress works out 86,000 lb. and 77,000 lb. respectively, on the same assumption as taken before, that is to say, they show 10,000 lb. less stress than *any* of the springs in Tables I and II of my article."]

"COLLISION DYNAMICS."

TO THE EDITOR OF ENGINEERING.

SIR,—Of course, we all know what Captain Tressider has tried to tell us about a shillingsworth of eggs; and, in ordinary conversation, it would sound pedantic or priggish to use more accurate terms of expression; but, when discussing scientific questions, we ought to be precise in our definitions and so prevent the mistaking of a mere *façon de parler* for a declaration of faith in what does not exist—there being no such thing as energy.

"Capacity for performing work" is not a *thing*, but only a *state* or condition of a body; and it is not possible to think clearly while talking in a loose way about matters in regard to which there is still too much uncertainty among engineers—as I ventured to point out in my first letter in ENGINEERING of April 9, page 490.

Thanking you for having assisted me in calling attention to this important subject,

I am, Sir, yours truly,
June 26, 1920. MECHANIC.

WORKMAN SHAREHOLDERS.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to the remark by Mr. Frederick Mills, quoted in the "Industrial Notes" on page 856 of your issue of the 25th ult., I have no doubt he is sincere in what he says about workmen owning the company they work in. Even if each man owned 100*l.* worth of shares it would not give him a return anything like what he would get if he struck work and gets another 10*s.* or 1*l.* a week by so doing. I beg to suggest that the average workman would look at it from his own point of view and not care a straw about the real future of the company. If the company failed he would walk off to another; 100*l.* would not give him sufficient interest to square his conscience; 1,000*l.* might.

How could a private house even carry on if all the servants had a share or voice even in the management?

The cause of most of the trouble in England at present is that too many *ignorant* people have a say in the management.

Yours faithfully,
June 28, 1920. "CIVIL ENGINEER."

THE LATE MR. WILLIAM HOWARD TAYLOR.—We regret to have to record the death which occurred under very tragic circumstances, on June 22, at Bolton Abbey, of Mr. William Howard Taylor, who was for several years manager of the Manchester office of Messrs. Peter Brotherhood, Limited, the Peterborough engineers. Mr. Taylor had gone to Bolton Abbey for a holiday with a party of friends, and probably recollecting the correspondence which appeared a short time ago in the daily press on the jumping of the Strid, he attempted that feat, but very unfortunately he alighted on a moss covered stone, lost his footing, fell backwards and was drowned. The part of the river where he fell is said to be of very great depth, and Taylor was drawn down by whirlpool effects and never rose again. His body was recovered late on the following day. The funeral took place last Monday. Mr. Taylor was in his thirty-eighth year. He was an associate member of the Institution of Mechanical Engineers.

THE INSTITUTE OF COSTS AND WORKS ACCOUNTANTS, LIMITED (BY GUARANTEE).—The first annual general meeting of this Institute, whose address is Donington House, Norfolk-street, Strand, W.C. 2, was held at the Hall of the Chartered Patent Agents, Staple Inn Buildings, Holborn, W.C., on June 4. Mr. R. J. H. Ryall, F.C.W.A., occupied the chair. The chairman, in submitting the council's report and accounts, congratulated the Institute on the fact that in spite of the difficulties of the post-war organisations, the membership had steadily grown. The Right Hon. Lord Leverhulme, P.C., had accepted the presidency, and the following had consented to become vice-presidents: Sir Robert Hadfield, Bart., D.Sc., F.R.S.; Sir Charles Wright Macara, Bart.; Sir Gerard A. Muntz, Bart.; Sir Herbert Austin, K.B.E., M.P.; Mr. Nevile Gwynne, M.A., M.I.N.A., M.I.Mech.E.; Mr. W. Howard Hazell; and Mr. Henry W. Allingham, M.I.Mech.E., M.A.S.M.E. Branches had been formed at Birmingham, Manchester and Glasgow. Branches at Sheffield, Bristol, Newcastle and other cities were in course of formation. The publication of an official journal was projected at an early date, and the Magazine and Library Committee had taken in hand the detail work connected therewith. The chairman pointed out to all members the importance of standardised costing systems and the definition of terms used in this important profession. A special committee to deal with this subject was being formed, and would be assisted by sub-committees created in all manufacturing districts. A number of other committees had also been brought into being to deal with various subjects.

THE INSTITUTE OF TRANSPORT.—As the needs of the community are multiplied and expanded, and improved methods introduced, so the desire to render the best service in a particular direction conduces to make men specialise in their work, and (whilst endeavouring to improve the knowledge by which such needs may be filled) to form fresh societies of engineering and allied interests. Such was the case directly the Ministry of Transport was created by the Government; men foremost in the railway, shipping and motor transport worlds combined for the study of this all-important subject and the Institute of Transport was called into being. The first dinner was held on Friday, June 25, under the presidency of The Right Hon. Sir Eric Geddes, who stated that the idea of the Institute was the development of scientific and economical transport by every known means; he wished to devote particular attention to the roads of the country which needed widening in many places and reconstruction in other parts to enable them to bear the heavy motor traffic of the future. He also announced that the Institute was in a position to offer annually four gold and one silver medals for papers on Railway, Road, Tramway and Water Transportation. Sir Gilbert Claughton, chairman, London and North-Western Railway, replying to the toast of the "Transport Industry," said he knew the railways would readily sink any small differences they might have and warmly support any proposal of the Ministry of Transport which was for the national good, but he contended that transport should be made to pay its way and that State ownership of railways was not to the advantage of the community.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Interest is largely centred in the market for raw and semi-finished materials. Among consumers, the opinion has steadily gained ground that the upward movement in prices is nearing exhaustion. At the moment, however, there is no sign of a fall in any section, this despite the fact that increasing quantities of American material are coming to hand at prices considerably below those quoted by home makers. The manufacturing branches would be materially assisted by an increased output of pig-iron, but this is rendered practically impossible by the shortage of fuel supplies. In addition, the advent of warm weather is reacting unfavourably on furnace production. Business in Derbyshire brands is on the basis of 12*l.* 5*s.* to 12*l.* 15*s.* for grey forge, and 12*l.* 12*s.* 6*d.* to 13*l.* 2*s.* 6*d.* for No. 3 foundry, f.o.t. at furnaces. Deliveries of West Coast hematites are arriving in Sheffield at 15*l.* 15*s.* to 16*l.* 5*s.* per ton. East Coast quotations are more favourable to buyers, but the tonnage of material available for local purchase is considerably less. The arrival of American supplies may cause makers of steel billets to moderate their quotations, though at the moment prices are firm, and the whole of the local output is going into immediate consumption. Compared with the local quotation of 25*l.* 10*s.* to 26*l.* for soft and hard basic billets respectively, plus a premium of 2*l.* to 3*l.* a ton for special deliveries, the American quotation stands at 23*l.* 10*s.* to 25*l.* c.i.f. Though the tonnage of American material coming to hand at present is not large, increased deliveries are promised in the near future, and it is understood that a fair number of orders have been placed from South Yorkshire. In the finished sections, though business is coming forward more slowly, production is maintained at high pressure. Rolling mills and foundries have heavy arrears to wipe off. The latter are being pressed by the engineering trade for increased deliveries of castings, but are seriously hampered by the shortage of pig-iron. The railways spring and axle departments are normally active. An improvement is noted in the demand for structural steel. Makers of special steels are seriously hampered by the dearth of vanadium, and are experimenting widely with substitutes. File makers are again doing a big business with the engineering trades. There is an unprecedented demand for joiners' and edge tools.

South Yorkshire Coal Trade.—Though the suspension of shipments has released a big tonnage of fuel for industrial use, the gross quantity available is not more than is required for immediate consumption and for stocking purposes, and the surplus for open market disposal is very limited. Steam hards are going away under pressure to manufacturers and railway companies. The best brands especially are in strong demand. Collieries will be in a better position to deal with orders when they regain possession of their own rolling-stock. Blast-furnace coke is in active demand at 65*s.* 9*d.* per ton on rail at ovens. Pressure on house coal has eased considerably. Depots have dealt with the bulk of their long-standing arrears, and would be glad to receive orders for winter stocking, but householders are holding off, apparently in the hope of reduced prices. Quotations:—Best branch handpicked, 37*s.* 2*d.* to 38*s.* 2*d.*; Barnsley best Silkstone, 37*s.* 2*d.* to 37*s.* 8*d.*; Derbyshire best brights, 35*s.* 2*d.* to 36*s.* 2*d.*; Derbyshire house coal, 32*s.* 8*d.* to 33*s.* 2*d.*; Derbyshire best large nuts, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire small nuts, 31*s.* 8*d.* to 32*s.* 8*d.*; Yorkshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; rough slacks, 28*s.* 2*d.* to 29*s.* 2*d.*; nutty, 27*s.* 2*d.* to 28*s.* 2*d.*; smalls, 23*s.* 2*d.* to 24*s.* 2*d.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Cleveland pig-iron continues exceedingly scarce, and the already very limited supply available for the open market has been further curtailed by the closing down of two blast furnaces at the Tees Bridge Ironworks, rendered necessary by an unfortunate accident. No iron is offered for sale to foreign countries, producers adhering strictly to their decision not to sell for abroad, and export prices are not named. The allocations of Cleveland pig-iron to Scotland for the month of July are understood to be no more than 5,000 tons, so that further purchasing of American iron for consumption North of the Tweed may be looked for. To home customers, No. 3 and the commoner kinds of Cleveland pig-iron remain at 217*s.* 6*d.* and No. 1 still stands at 230*s.*

Hematite Iron.—Hematite is almost as difficult to purchase as is Cleveland pig-iron. Most makers have sold as extensively as they care to commit themselves; but in addition to the very limited home business passing, occasional small odd lots can still be picked up for despatch to the allies. For home consumption, Nos. 1, 2 and 3 East Coast brands are 260*s.*, and No. 1 is 262*s.* 6*d.*; whilst for shipment to France, Belgium and Italy, mixed Nos. are 265*s.* and No. 1 is 267*s.* 6*d.*

Foreign Ore.—In the continued absence of transactions foreign ore quotations are nominal. Some sellers are inclined to take a slightly firmer attitude, but consumers are very well placed, and are not in the market to buy. The latter are not only carrying considerable stocks, but they have substantial contracts made, against which large quantities are coming forward. They declare that they could, without difficulty, place orders or delivery over the third quarter of the year on the basis of the business last reported, viz., 49*s.* for rubio, of 50 per cent. quality, on the 17*s.* parity freight, Bilbao-Middlesbrough, which makes the present c.i.f. Tees value

of best rubio 58*s.*, as steamers from the Spanish ore port are now being chartered at 26*s.*

Coke.—Coke keeps steady, firm, and in heavy request. A very extensive foreign business could be done if there were supplies for such trade, but little indeed is available for sale to overseas customers. For export gas coke ranges from 180*s.* to 200*s.*; and foundry description is in the neighbourhood of 170*s.* Home requirements are large. With ample supply to meet the great needs of this district, there is much local activity. Medium blast-furnace quality is 62*s.* 9*d.* at the ovens, and low phosphorus sort is 65*s.* 3*d.* at the ovens; while foundry coke is 70*s.* 3*d.* for home purposes.

Manufactured Iron and Steel.—Though finished iron and steel manufacturers have heavy bookings, and are not particularly seeking further contracts, some apprehension is felt at the cancellation of shipbuilding orders, and the fact that America, and Belgium, are not only competing successfully for Continental trade, but are sending some of their output to this country. Values are well upheld. Principal market quotations stand: Common iron bars, 30*l.*; marked bars, 32*l.*; iron angles, 30*l.* 15*s.*; rivets, 38*l.*; steel ship, bridge and tank plates, 23*l.* 10*s.*; steel angles, 23*l.*; steel joists, 23*l.*; soft steel billets, 25*l.* 10*s.*; hard steel billets, 26*l.* 10*s.*; heavy steel rails, 23*l.*; fish plates, 28*l.*; black sheets, 44*l.*; and corrugated galvanised sheets, 54*l.*

Ironstone Miners' Wages.—A motion asking for an all-round advance of 2*d.* per ton on the base rates to ironstone miners and to quarrymen in the association was passed at a meeting of the Council of the Cleveland Ironstone Miners and Quarrymen's Association, held at Middlesbrough this week. This decision will be brought before a joint meeting of mine owners and the men's representatives to be held at an early date.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—Little change of any kind has taken place in the Scotch steel trade during the past week and the active state which has prevailed recently still continues. The work on hand, amounting as it does to such a large tonnage, will take some time to get cleared off the books, and with buyers holding back and not committing themselves beyond their bare necessities in the meantime, the future position is not just as bright as it was. There seems little cause for alarm, however, as many months must elapse before there need be any talk of a slowing down of plant, and by that time the position may be quite changed. For the present there is as great a demand as ever, and much pressure is being brought to bear on makers in order to get supplies of all classes of material. The home trade is consuming an enormous quantity of stuff, but perhaps a shade more is, of late, finding its way abroad. Deliveries are not large enough to please customers, but makers are endeavouring to keep all trades going, and a big effort is being made to despatch a large amount during the next two weeks. The black sheet makers are exceptionally busy with the home trade and Colonial buyers are in the market with a heavy demand also. Ship and boiler plates are in active request, and sectional material is also in good demand. Prices are steady.

Malleable Iron Trade.—In the malleable iron trade there is a continuance of recent conditions, and all mills are fully employed. In order to secure supplies before the holidays for fear of any delay in the restarting of the mills consumers are pressing for better deliveries of bars, but as everything is being divided round and output is not increasing it is difficult to see what more can be done. Quotations show no change, but an easier tone is being looked for by buyers who are not placing fresh orders rashly, but are first carefully considering both the probable costs and probable date of delivery.

Scotch Shipbuilding.—The shipbuilding returns from the different districts in Scotland for the past month are not as good as it was hoped they might be, and the total only amounts to 25 vessels of 45,897 tons, made up as under:—

	Vessels.	Tons.
The Clyde	18	42,249
The Forth	2	2,757
The Tay	1	800
The Dee, and Moray Firth	4	91
	25	45,897

While these figures are under the average monthly tonnage for the year they help to bring the return for the half-year up to quite a respectable total. For that period the outputs are:—

	Vessels.	Tons.
The Clyde	93	286,946
The Forth	16	23,127
The Tay	5	10,623
The Dee and Moray Firth	26	4,442
Total	140	325,138

The tonnage launched from the Clyde yards during the months of June was less than half of the total for the months of April, and is the lowest June output since 1912. That for the half-year to date, however, has only been bettered on five other occasions, the record for the period under review being in the year 1913, when 127 vessels were launched with an aggregate of 348,476 tons. Several circumstances have put a check on output, chief among them being the great difficulty experienced in securing supplies of steel, coal and other material; there is the shorter week being worked in the yards. Everything has seemed to be against a new record being put up this year, and few now look for such being accomplished. The very high costs which have now been found necessary for new tonnage have had the effect of reducing fresh business, and not only that but also of causing buyers to cancel orders. Owners say that breaking point has been reached, and that as the freight outlook is none too healthy it is quite impossible to place orders for new steamers without some idea of what the actual cost will be. A number of contracts with Clyde shipbuilders have been erased from their books by mutual agreement between them and the buyers, and if there is any extension of this procedure the outcome may have the effect in the not far distant future of causing reduced employment in the district. A day of reckoning is most assuredly coming.

Scotch Pig-Iron Trade.—No increase in the amount of Scotch pig-iron available for distribution can be noted, and consumers are experiencing difficulty in securing anything like what they require. The great scarcity has been a serious question for long enough now and a larger output does not seem possible, with the result that practically nothing beyond a very odd lot is being shipped overseas. The steelmakers are not getting large enough supplies of hematite, and the same is the case with consumers of foundry iron. Demands for better deliveries are general, but makers cannot do the impossible. Prices are very strong, and even were regular customers making any demur there are many others, both at home and abroad, anxious to be supplied, and who are ready to pay what is asked so long as they could get deliveries. The export figure for foundry iron is round 16*l.* 10*s.* per ton or No. 1 quality, and about 16*l.* for No. 3 quality.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

New Coal Export System.—New arrangements have been made in connection with the Government limitation of exports with its consequent allocation upon each colliery of the quantity to be shipped as cargo and bunkers for foreign-going vessels. In order to prevent coal being shipped in excess or irrespective of allocations, the South Wales Coal and Coke Supplies Committee have put into operation a system of permits in denominations of 10 tons to 1,000 tons. Each colliery company receives permits for the quantity allocated to it for cargoes foreign and/or bunkers for United Kingdom depots and vessels proceeding to foreign destinations respectively. The permits cover a month's allocations, but the quantity allocated for shipment is still a weekly one with a fortnightly average, but any balance undelivered may be carried forward to a future week. The permits are issued to exporters by the colliery company, and applications for releases with the necessary permits attached are submitted to the Coal Mines Department for the usual endorsement. Each permit must have the description of coal, name of shipper, name of vessel, destination, date and name of the colliery company filled in and signed by an official of the company. The new system, though removing many difficulties does not increase the quantity of coal available for shipment, and this is the principal cause of the present stagnation in business. The amount available for export is in many cases insufficient to allow collieries to deliver contract quantities and consequently there is practically no coal for disposal on the open market, while buyers experience much difficulty in making up even small cargoes. Owing to a decrease in the demand for bunkers the Coal Supplies Committee have decided to reduce bunker allocations by 9 per cent. and to increase cargo allocations by 9 per cent., and though the volume of coal available for shipment at the docks remains unchanged the position will be slightly relieved as collieries will be able to supply more coal for shipment as cargo for which they will be able to realise about 30*s.* per ton more than for bunkers. Foreign exports in the past week, at 182,500 tons were the smallest for any week in the current year, and compared with 462,000 tons in the week ended January 16. Of last week's shipments, 105,150 tons went to France, 26,680 tons to Italy and 19,820 tons to British coaling stations. Small parcels of coke are occasionally released for export, and sellers have no difficulty in securing 180*s.*, while patent fuel is scarce and firm at 140*s.*, with small coals for manufacturing purposes available at 60*s.*

The Iron and Steel Trades.—Business is quiet with the general tone easier. Tin plates are in quiet demand, with standard boxes ranging from 66*s.* to 71*s.*, while terms are in active request at 125*s.* to 126*s.* Galvanised sheets are steady at 55*l.*

Cardiff Shipping Deal.—It is reported that Mr. Frank Shearman, of the Mountstuart Dry Docks, Limited, and John Shearman and Co., Limited, Cardiff, have acquired a controlling interest in the R. B. Chellew Steam Navigation Company, Limited, which has an issued capital of 485,500*l.*, and controls a fleet of 10 steamers of 55,000 tons deadweight.

THE IRON AND STEEL TRADES DURING THE WAR.—The Royal Statistical Society, 9, Adelphi-terrace, Strand, W.C. 2, has issued, at the price of 1*s.* 6*d.*, in pamphlet form, the paper which was read before it, on March 16 last, by Mr. M. S. Birkett, O.B.E., on "The Iron and Steel Trades during the War." The paper reviews, under all its various aspects, the situation with reference to this country, France and the United States, and contains a table of production and exports of iron and steel for these three countries and for Germany in 1913, 1918 and 1919. It concludes with an account of the discussion which took place on the paper at the meeting. We welcome the publication as a handy source for reference purposes.

NOTICES OF MEETINGS.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Wednesday, July 7, at 6 p.m. Free Illustrated Lectures in the Canada Building, Crystal Palace, London, S.E. "Wild Catting," by Mr. E. H. Cunningham-Craig, B.A., F.R.S.E., F.G.S.

THE INSTITUTION OF NAVAL ARCHITECTS.—Summer Meeting, at Liverpool, July 6, 7, 8 and 9. Tuesday, July 6, 10 a.m., in the Council Chamber of the Town Hall. Welcome by the Lord Mayor of Liverpool, followed by the reading and discussion of the following papers: "The Function of the Merchant Ship," by Sir Norman Hill and "Some Features in the Design and Construction of Mercantile Vessels Considered in the Light of Recent War Experience," by Professor J. J. Welch. In the afternoon of that day a visit will be paid to Messrs. Cammell Laird and Co.'s Birkenhead Works, a reception will later be held on the White Star liner Baltic, and in the evening a reception will be held by the Lord Mayor in the Town Hall. Wednesday, July 7, at 10.30 a.m.: The following papers will be read and discussed in the Lecture Hall of the Central Technical School, "Safety of Life at Sea," by Sir Westcott S. Abell,; "Subdivision of Passenger Ships," by Mr. George Webster. In the afternoon a visit will be paid to Messrs. Lever's Works at Port Sunlight, and in the evening at 7.30 p.m. the dinner of the Institution will be held at the Midland Adelphi Hotel. Thursday, July 8, at 10 a.m.: The following papers will be read and discussed in the Lecture Hall of the Central Technical School: "Some Experimental Work in Connection with Diesel Engines," by Engineer-Commander C. J. Hawkes; "Comparative Trials of 'Still' and 'Sulzer' Engines under Actual Working Conditions on Board Ship," by Mr. William Denny; "The Efficiency of Propulsion of Full-Sized Ships," by Mr. C. Frodsham Holt. In the afternoon there will be an excursion on the River Mersey and a reception on the Aquitania. Friday, July 9: Full day excursion to Messrs. Vickers' works at Barrow-in-Furness.

"MACHINERY'S" SCREW THREAD BOOK.—We have received from *Machinery*, 51 and 52, Chancery-lane, W.C. 2, a copy of the revised (third) edition of their screw thread book, which, after definitions of the various elements of a screw thread, gives data on the Whitworth standard thread, the British Association thread, the British standard brass thread, other British threads, the Lowenherz, the International system metric screw, the French, United States, and numerous other threads. It deals also with screw thread measurements and tolerances.

NEW "MAZDA" GAS-FILLED LAMPS.—The British Thomson-Houston Company, Limited, 77, Upper Thames-street, E.C. 4, announce the successful production of a 40-watt, 100-volt to 130-volt, and a 60-watt, 200-volt to 260-volt gas-filled lamp. Both have ring filaments, and can be operated in any position. They are normally fitted with standard bayonet caps. The approximate overall dimensions of the 40-watt, 100-volt lamp are, diameter 2⅜ in., length 4¾ in.; and of the 60-watt, 200-volt lamp, diameter 2⅜ in., length 5¼ in.

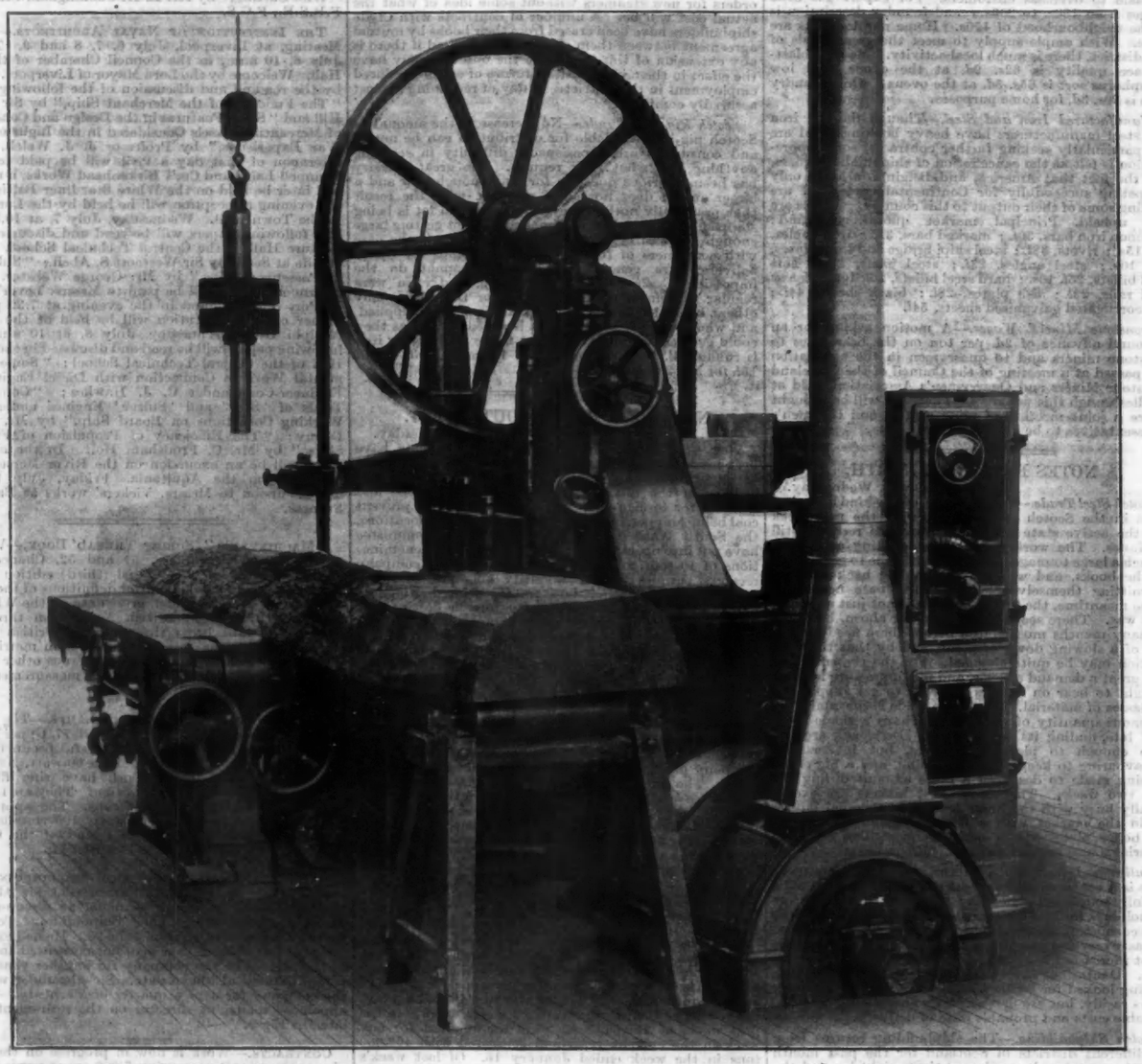
FAIRFIELD ENGINEERING AND SHIPBUILDING COMPANY, LIMITED.—We are informed that Sir Alexander Gracie, K.B.E., M.V.O., the managing director of the Fairfield Engineering and Shipbuilding Company, Limited, has retired, as from June 30. He had expressed his desire to retire a year ago, but consented to remain in the service of the company for another year, which period expired at above date. Sir Alexander was with the company for over a quarter of a century. He was appointed managing director on the retirement of the late Dr. Elgar.

CONTRACTS.—Work is now in progress on the laying of a concrete raft measuring 7,000 super yards for two new factories being built by Messrs. Watney, Combe, Reid and Co. The reinforcing is on the Walker-Weston system comprising an interlocked double-layer framework of a depth of 5½ in. between top and bottom layers for a 9-in. depth of concrete. The Walker-Weston Company, Limited, invite engineers to view the reinforcement which is being made and laid on the site of the factories. The work is under the supervision of Mr. M. T. Saunders, architect and surveyor to Messrs. Watney, Combe, Reid and Co., Limited.

BRITISH CAPITAL AND FOREIGN COMPETITORS.—The journal *Production and Export* for May, of the British Empire Producers' Organisation, 3 to 7, Old Queen-street, Westminster, S.W. 1, lays stress upon the fact that in the past British municipalities have borrowed hundred thousands of pounds to build a power plant, or a water works and have then placed contracts for the whole of the machinery with foreign countries. "Indeed," it adds, "this kind of thing was more the rule than the exception in some parts of the Empire, and the British manufacturer had the humiliation of seeing British capital, which he could not borrow himself, used directly for the benefit of the trade of his foreign competitors. This practice of spending British capital outside the Empire was by no means confined to public bodies. Private companies were equally regardless of their duty to support manufacturers within the Empire. One striking case among many occurred in connection with the development of the power supply of the Rand, at Johannesburg. Something like 2,000,000*l.* were borrowed in London for this purpose, and practically the whole of the machinery purchased with this money was procured from Germany."

BAND RE-SAWING MACHINE.

CONSTRUCTED BY MESSRS. THOMAS ROBINSON AND SON, LTD., ENGINEERS, ROCHDALE.



We illustrate in the engraving on the present page an electrically driven band re-sawing machine, built by Messrs. Thomas Robinson and Son, Rochdale. The maximum width of the saw is 6 in., the saw pulleys are 54 in. in diameter and are mounted on heavy steel shafts, running in enclosed self-aligning double-row ball bearings. Both saw pulleys and spindles are carefully balanced and ground true. The vertical adjustment of the upper pulley is over a range of 6 in. and the saw has a length of 27 ft. The approximate power required by the machine is 40 brake horse-power. The upper pulley has staggered arms radiating from a dished boss in which the bearing is nested, the arrangement preventing any overhang of the pulley and ensuring that the strain on the saw comes directly over the centre of the bearing. The lower pulley, which is similarly mounted, is cast solid with a heavy rim, and being heavier than the upper one, prevents any possibility of the latter over-running when under a severe load. The straining device for the saw is highly sensitive and the finest gauge saws may be used with advantage.

There are both vertical and horizontal feed rollers. The vertical ones consist of two large diameter fluted rollers mounted on a powerful radial arm carried below the table. The spindle carrying the vertical feed rollers is supported in a socket and can be quickly removed when required, as for cutting very wide flitches or slabs. The rollers are adjusted up to the fence by a handwheel; a pedal brings them away to suit any variation in the width of the timber being sawn. Our illustration shows these rollers removed and suspended over the table of the machine. The horizontal feed rollers are connected by chain gear and are specially suited for feeding pitch pine logs or heavy flitches. They can be worked in conjunction with, or separately from, the vertical feed rollers. The fence is of an improved patented design; it can be adjusted quickly and is provided with a rack and pinion movement, a simple locking device and a screw for fine adjustment. It has also a canting motion, corresponding with a similar feature in the vertical feed rollers, for cutting weather boards, &c. The saw guides, above and below the table, are filled with adjustable hard wood packings. Cleaning devices keep the saw pulleys clear of pitch and gum, and provision is also made for keeping the saw blade clean and lubricated.

The machine is capable of sawing deals and battens at feeds up to 200 ft. per minute; it will cut also any size of board or flitch up to 20 in. deep, and cut the widest flitches. It can, further, convert round logs up to 16 in. in diameter. All these operations can be carried out without special changes or adjustments.

ROYAL AERONAUTICAL SOCIETY.—We are informed that His Royal Highness the Duke of York, K.G., has graciously consented to become a patron of the Royal Aeronautical Society, and that Air Marshal Sir Hugh Trenchard, Chief of the Air Staff, and Commander J. C. Hunsaker, U.S.N., Assistant for Aeronautics to the Chief of the Bureau of Construction and Repair of the United States Navy Department, have been elected Honorary Fellows of the Society. As a result of a council ballot, Air Commodore H. R. M. Brooke-Popham, has been duly elected chairman of the society for the ensuing session, assuming office in October next. Arrangements have now been made for a reception room for the use of members of the society to be available at Olympia during the Aero Show, which opens on the 9th inst. and remains open until the 20th inst.

RAILWAY AND TRAMWAY MATERIALS YEAR BOOK.—The French Association of Manufacturers of Railway and Tramway Materials (Chambre Syndicale des Fabricants et des Constructeurs de Matériel pour Chemins de fer et Tramways), 7, Rue de Madrid, Paris, 8, have issued their year book for 1920–21, which contains information on all the French works which manufacture material required for permanent way, and construct rolling-stock for railways and tramways. The location of the works, the capital, specialties dealt with, &c., are stated. A separate chapter of special interest gives the specifications of the French railways for various classes of material. The book is also a directory of the members of the Board and of the managing staff of the French railway companies and the French State Railways. It can be obtained at the price of 20 francs from the above address.

THE LINCOLN WORKS OF MESSRS. RUSTON AND HORNSBY, LTD.

(*For Description see page 4.*)

FIG. 3. ROAD ROLLER ERECTION SHOP.

FIG. 4. OIL ENGINE ERECTION SHOP.

(*To face page 4.*)

THE LINCOLN WORKS OF MESSRS. RUSTON AND HORNSBY, LTD.

(*For Description, see Page 4.*)

FIG. 5. THE NEW PATTERN SHOP.

FIG. 6. THE BOILER SHOP.

(*To face page 5.*)

THE WHITE OIL-FUEL BURNING SYSTEM.

MR. W. A. WHITE, ENGINEER, NEWCASTLE-ON-TYNE.

(For Description, see Page 23.)

Fig. 1.

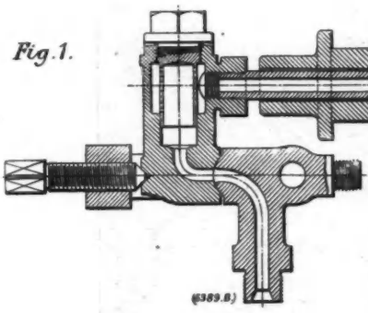


Fig. 2.

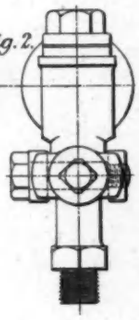


Fig. 3.

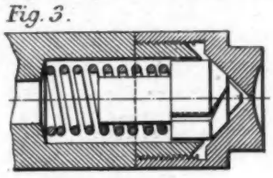
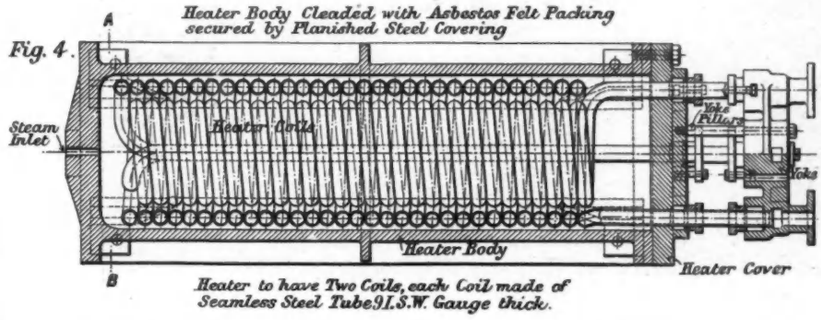


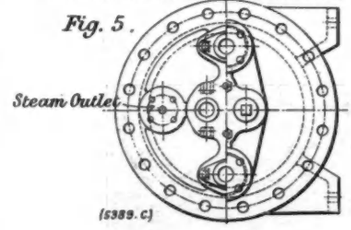
Fig. 4.



Heater to have Two Coils, each Coil made of Seamless Steel Tube 9 I.S.W. Gauge thick.

VIEW OF TOP OF HEATER WITH YOKE REMOVED. | VIEW OF TOP OF HEATER LOOKING ON YOKE.

Fig. 5.



SECTION A.B. | VIEW LOOKING ON BOTTOM OF HEATER.

Fig. 6.

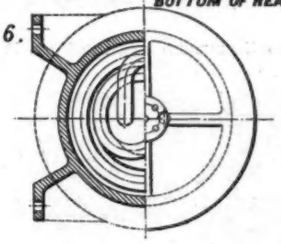


Fig. 7.

SECTION ON A.A.

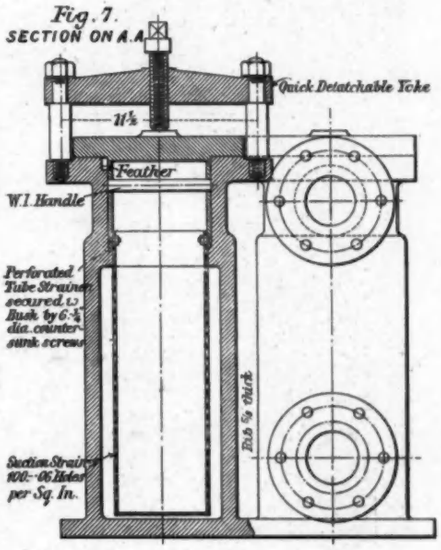

Quick Detatchable Yoke
1¼
Feather
W.I. Handle
Perforated Tube Strainer secured to Bush by 6 ⅛ dia. counter sunk screws
Section Strainer 100–06 Holes per Sq. In.
Bush ⅝ Thick

Fig. 8.

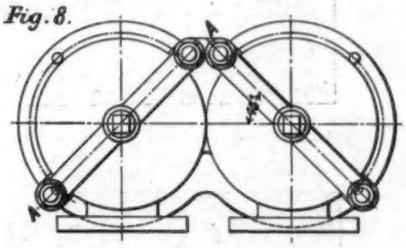


Fig. 9.

SECTION ON B.B.

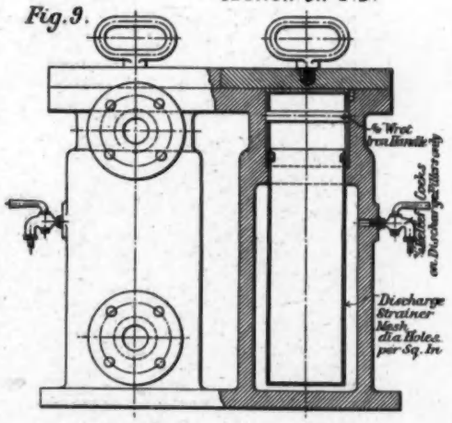


Fig. 10.

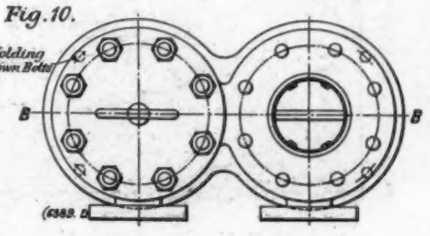


Fig. 11. SECTION AT XY.

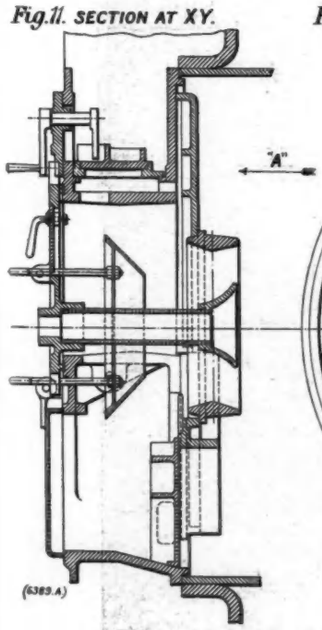
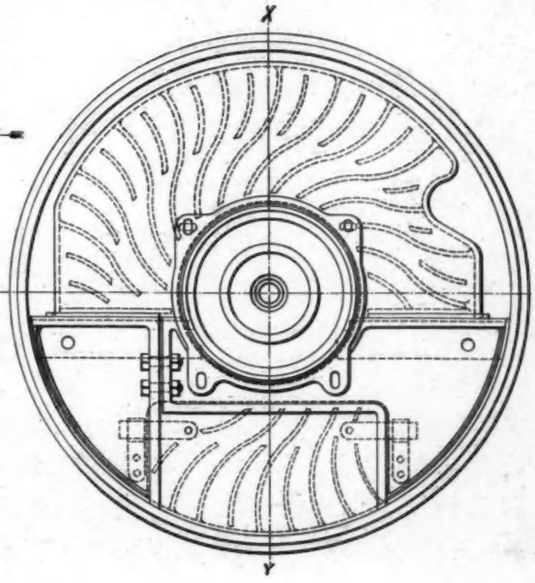


Fig. 12. VIEW LOOKING IN DIRECTION OF ARROW "A".



(To face page 22.)

THE WHITE OIL-FUEL INSTALLATION ON S.S. "AQUITANIA."

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, ENGINEERS, NEWCASTLE-ON-TYNE.

(*For Description, see Page* 23.)

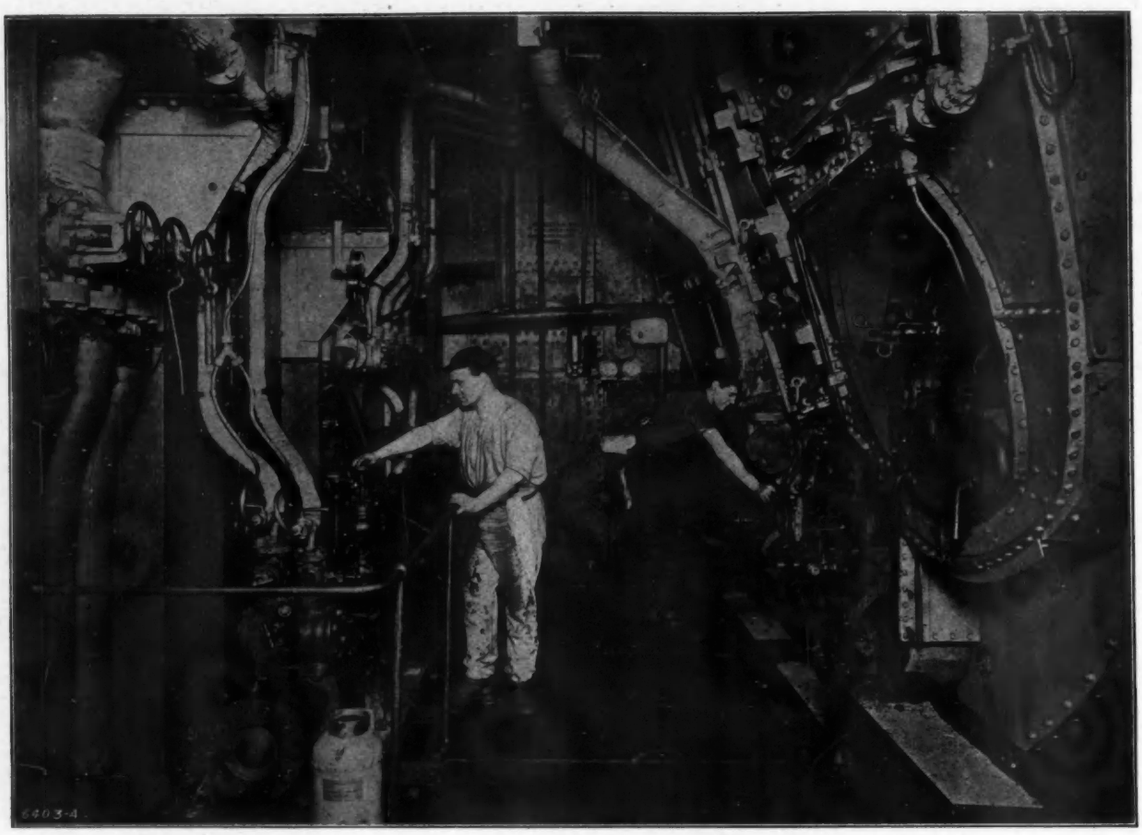


FIG. 13. SINGLE STOKEHOLD SHOWING FUEL PUMP.

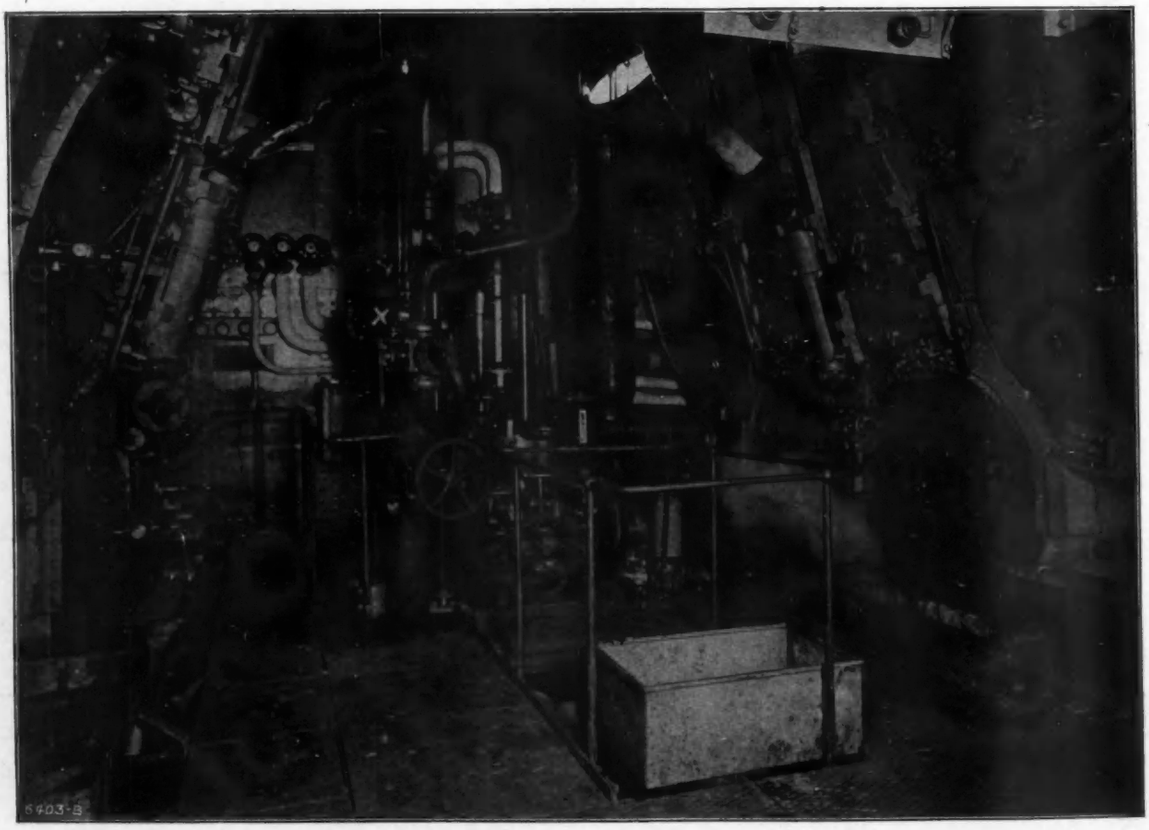


FIG. 14. DOUBLE STOKEHOLD SHOWING TRANSFER PUMP.

(*To face page* 23.)

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.
BELGIUM, Brussels: E. F. Satchell, 56, Rue du Tabellion.
CANADA, Toronto, Ont.: Wm. Dawson and Sons, Manning Chambers.
EDINBURGH: John Menzies and Co., 12, Hanover-street.
FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Advertisements, Agence Havas, 8, Place de la Bourse.
GLASGOW: William Love.
INDIA, Calcutta: Thacker, Spink and Co., Bombay: Thacker and Co., Limited.
ITALY: U. Hoepli, Milan. Anonima Libraria Italiana, Torino. And any post office.
LIVERPOOL: Mrs. Taylor, Landing Stages.
MANCHESTER: John Heywood, 143, Deansgate.
NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.
NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.
ROTTERDAM: H. A. Kramer and Son.
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With Two One-Page Plates of the LINCOLN WORKS OF MESSRS. RUSTON AND HORNSBY, LIMITED; and Two One-Page Plates of the WHITE OIL FUEL INSTALLATION ON SS. "AQUITANIA."

NOTICE.

A few months ago the Proprietors of "ENGINEERING" were compelled to advance the price of this Journal to 1s. per copy, owing to the enormous increases in the cost of paper, engravings and printing, &c. Now higher transport and delivery charges involve a further increase to 1s. 2d. per copy, and this price dated from and included the issue of Friday, April 2, 1920. So long as postal rates remain as at present there will be no increase in the price of copies sent by inland post, which will continue at 1s. 2d. post free.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions still imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents will not have copies for chance customers; therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 15.

ENGINEERING.

FRIDAY, JULY 2, 1920.

RAILWAY MANAGEMENT.

FATE, or Captain Wedgwood Benn, has dealt somewhat unkindly with Sir Eric Geddes. On Thursday of last week he was prevented on a point of order in the House of Commons from explaining his proposals for the future control of our railways, and the same interdiction operated the following night at the dinner of the Institute of Transport. An expectant country managed to contain itself until last Tuesday evening, but Sir Eric has unfortunately had to put forth his scheme in the nakedness of a White Paper, sheltered, introduced and followed by none of expository comment and rosy optimism which might have accompanied it had he been allowed to unfold it in person. Sir Eric certainly did his best with an unfortunate situation at the Institute of Transport when he referred to the coming White Paper as a glimmering ray which would ultimately enlighten the obscurity of the transport situation, but how much better might he have done had the proposals been before the House of Commons. We cannot but think that somewhere there exists an unspoken peroration which in rotund periods tells how this railway scheme will form a bridge to the land fit for heroes and the new age.

We are unkind enough to think that it is just as well that this scheme has had to be put forward in such a way that it must be taken on its merits. Those interested have to judge for themselves what the scheme means; their understanding is not obscured by Sir Eric's interpretation of what he thinks it means. The broad lines of the matter will be familiar to our readers. The railways are to be divided into geographical groups and the various railways forming one group are expected to amalgamate. If they do not do this voluntarily in a reasonable time they are to be forced to it by the Ministry of Transport. We have referred to the groups as geographical, but this is not actually correct. The groups combine various existing railway systems and as nearly as possible are confined to railways operating in one geographical area. For instance, the Southern Group contains the South-Eastern and Chatham, the Brighton and the South-Western lines; while the Western Group contains the Great Western and the Welsh lines. The South-Western and the Great Western to some extent serve the same area so that one has a crossing of the groups, but at the present stage of affairs this is probably unavoidable. From the point of view of the actual constitution of the groups the scheme we take it is a preliminary one and it is pointed out that it would be open to the group companies to exchange between themselves lines which project from the territory of one group to another. It is suggested that at a later stage it may be necessary to require them to do this.

We are not at the moment inclined to criticise the constitutions of the groups since, as we have said, we take them to be little more than suggestive. It may be that we are wrong in this and that they represent the results of the labours of the technical staff of the Ministry. If so it is curious that the groupings are such as anyone could have thought out in five minutes and without even looking at a map. The actual determination of such grouping will demand a considerable amount of detailed inquiry into running powers, services, leases, and other existing arrangements. It is not necessary to consider the groups in detail now, but it is interesting to note that if constituted as suggested they would be of far from equal importance. The North-Western Group would, for instance, control three times the length of line controlled by either the Southern or North-Eastern Groups. It is also of interest to note that while some lines have to combine with all sorts of people the North-Eastern is left alone further than being instructed to take over the Hull and Barnsley Railway. The Great Western also has nothing to do but buy up the Welsh lines.

We cannot deal with every detail of the White Paper, but there are two other important proposals to which we must refer. These deal with management and finance. In connection with the former it is suggested that the board of a system of grouped railways should be limited to twenty-one members. We have no objection to this and Sir Eric may further reduce the number without incurring our criticism. The work of any board is always done by comparatively few men, and although some passenger members may be necessary to watch certain interests there is more than enough room for such representation in a total of twenty-one. The more important proposals in connection with the boards of management are for their constitution. It is proposed that representatives of the shareholders should form a majority on the boards, but in addition a certain number of employees would be elected as members. The proposed proportion between the shareholders' representatives and the employee members is not stated. Of the employee members it is suggested that one-third should be leading administrative officials of the group co-opted by the rest of the board and the remaining two-thirds elected from and by workers on the railway.

The boards of directors of our railway companies in the past have perhaps not been greatly to the credit of the shareholders. There has been too great a tendency to elect members for eminence in any walk of life other than railway management. The system has certainly worked fairly well, but that is because, as we have already said, the work of any board is always done by a few men. It would always have been better if some of the responsible officials had been members of the railway boards and the recommendations in this direction are quite sound. The further proposal for the admission of workman members to the boards will excite little surprise and probably little opposition. Ten years ago the scheme would have been considered fantastic, but there is a consciousness now abroad that the best way to control the somewhat unreasonable demands of labour is to give labour a representation in the control of industry. In that way it may learn at first hand what the difficulties of industry are and may be brought to realise that no ultimate prosperity for itself or anyone else can lie in demands which are beyond economic justification.

In a general way we do not object to these proposed reforms in the boards of management, but there is one aspect of the matter which we have not yet considered which goes down to the root of the whole question of the future of the railway. It appears to be admitted that the railways are privately owned, but it does not appear to occur to the framers of this scheme that these private owners may not be prepared to accept these mixed boards which are to be thrust on them. A board member, or members, representing the employees in a business may very possibly prove of great value to all concerned, but the appointment of such members by the owners of a business is a very different thing from the creation and endowment of them by an outside authority which has no financial stake in the matter. If the thing is done by Act

of Parliament the owners will have to put up with it, and as far as their existing stake in the railways is concerned they will be able to do nothing. The mischief will be, however, that they will show no tendency to increase that stake and that will mean deadlock, since the railways cannot carry on without more capital and a lot of it.

The same matter comes up again in connection with the financial proposals. To quote the White Paper:—"The Act of Parliament should lay it down that rates and fares shall be fixed at such a level as, with efficient and economical management, will in the opinion of a prescribed authority enable railway companies to earn a net revenue substantially equivalent, on some pre-war basis to be settled in the Act, to the combined net revenue of all companies absorbed in the group." This is sufficiently vague to allow of it being interpreted to mean anything when the proposals come before Parliament, but this is not the end of the matter. It is suggested that with due care and economy it should be possible for group companies to improve on their pre-war returns. If they do this, however, as an offset to the State having very materially extended their "charter," the State is to take a share of this improvement. The proportion is not stated.

We assume that the Government is sincere in its statement that it does not wish to nationalise the railways, but if it really carries through these proposals we cannot imagine what other end to the matter there can possibly be. The private owners of the railways are to have considerable outside representation imposed on their boards of management. They are to be allowed to make their pre-war dividend, or its equivalent, but if by "care and economy" they make more, part of it is to be taken by the State. If they make less, however, we do not gather that the State makes up the difference. How such a "heads I win, tails you lose" system is ever going to attract any new capital to the railways is more than we, or anyone else, can imagine. The whole scheme is futile and if put in operation in the terms of the White Paper will and can lead to nothing but railway nationalisation. We have sometimes thought the criticism of the salary list of the Ministry of Transport was overdone and have recognised that an adequate technical staff cannot be got together for a starvation wage, but if this remarkable White Paper represents the best that the staff can do we are inclined to endorse all that has been said about extravagance.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.

FROM Monday to Friday of last week a very successful function was carried out by the Institution of Automobile Engineers. The function was officially described as a summer visit, but as the excursion which was undertaken extended from Derby through Sheffield to Manchester, and covered inspection of the works of some twenty different firms, the visit may be said to have extended to visits. Apart from these inspections of works, the function was of a social nature only and no technical or other papers were read. The practice of holding summer meetings of this type has shown a tendency to extend of recent years, and the Institution of Electrical Engineers is this year allowing itself the same relaxation. We do not now feel called upon to argue the respective merits of summer meetings with or without the reading of technical papers, but as evidence on one side we can certainly testify to the very successful and pleasurable nature of the recent excursion of the Automobile Engineers.

The programme of events began on Monday evening, the 21st ult., when the meeting started at Derby, the majority of the members attending having travelled from London. An informal dinner was held at the Midland Hotel, Derby, that evening, when we had the pleasure of accepting the hospitality of the President of the Institution, Mr. Thomas Clarkson. In the course of the next day visits were paid to the works of Messrs. Rolls-Royce and the Midland Railway Company. The visit to Messrs. Rolls-Royce's works took place in the morning, and was followed by a luncheon given by the firm to the members of the institution. We cannot here attempt to describe the works of Messrs. Rolls-Royce. Their products and the quality of their products are well known and their factory methods suggest an attention to individual detail which cannot be given in the mass production methods on which we have in the last year or so received such a large amount of advice from people who know nothing about them. It was surprising to find that Messrs. Rolls-Royce are still turning out some dozen aero-engines a week. The financial history of the firm would suggest that they are not only turning them out but are selling them. The engines are mostly of the new "Condor" type. The firm's motor car programme aims at a output of some fifty cars a week. The best figures are now, we believe, somewhere between thirty and forty, the output having so far been limited by the impossibility of obtaining sufficiency of some of the heavier forgings.

At the afternoon visit to the works of the Midland Railway Company the members had the pleasure of meeting Sir Henry Fowler, the president-elect of the Institution. As we have not space here to describe the works of Messrs. Rolls-Royce, still less have we space to deal with the Midland Railway Company's extensive establishment. Owing to the extent of the works and the fact that the party had to leave for Sheffield in the course of the afternoon, the visit was somewhat hurried, but time was found to inspect all important departments. Among matters in which we were specially interested we may mention the casting of railway chairs which is carried out on a very extensive scale at Derby. The point of interest about the matter is that moulding machines are not used. At first sight such machines would appear the obvious equipment for a repetition job of this sort, but Sir Henry Fowler assured us that the work was not carried out in the way it was without the alternative of a moulding machine plant having been considered. Investigation had showed that for this particular work there would be required at least two men moving moulding flasks for one making moulds, and that a better output with less labour was obtained with the system used. The job being invariable it was carried out by having a series of flasks arranged in rows on the shop floor. The flasks were never moved beyond such moving as was necessary for filling and emptying them. The moulding sand also was not carried about in any way, being tipped out of the flasks when a formed chair was removed and re-used for the next filling. There was absolutely no carting about of anything except the wood pattern which the moulder carried with him as he worked down a row and the removing of the finished chairs.

The other matter which we specially noted at Derby was a Lenoir gas engine in the works museum. This engine was in actual operation at Loughborough until a year or so ago; as its running time was confined to three hours a week there was no justification for undertaking capital expenditure on a more modern engine. Sir Henry Fowler informed us that the engine worked quite satisfactorily up to the last. The preservation of this old engine in a works museum in place of breaking it up is an admirable procedure. The Midland Railway works are at present to a very large extent engaged on reconditioning work with a view to making up some of the arrears of the war. The new engines being built are of a three-coupled goods type and are fitted with Fowler-Anderson superheaters. The output of these new engines is at the rate of about one a week and of reconditioned older engines about twenty a week. At the conclusion of this visit the members of the Institution were entertained to tea at the Midland Railway Institute by Sir Henry Fowler.

The Sheffield programme began on the evening of the day of the Derby visits when a reception was given by the Sheffield Local Reception Committee in the Grand Hotel. The whole of the arrangements in Sheffield were in the hands of this committee, and the success of the Sheffield part of the expedition was evidence of the good work they did. The technical features of the Sheffield visit consisted in the inspection of various industrial establishments. So many firms had issued invitations to the Institution that it was impossible for the individual member to visit more than a small proportion of the works available. The list of firms covered Messrs. J. H. Andrews and Co.; Edgar Allan and Co.; J. Brown and Co.; Brown Bayley's Steel Works; Cammell Laird; Thomas Firth and Sons; Firth-Derihon Stampings, Limited; Hadfields; Jonas and Colver; Kayser Ellison; A. Lee and Sons; G. Turton, Platts and Co.; Sanderson Bros. and Newbould; Ambrose Shardlow and Co.; Steel, Peech and Tozer; and Vickers, Limited.

These works, as will be seen, represent in a fairly complete way the heavy industries of Sheffield. Although not engaged in the construction of motor cars, they deal in the most important raw material of the automobile engineer, and this visit of the members of the institution should be of much value to both sides. It was remarkable to note to what a very large extent some of the Sheffield steel firms are now engaged on the manufacture of material for the motor car trade. This was particularly noticeable, for instance, in connection with Messrs. Vickers, which was one of the firms whose works we personally happened to visit. In steel manufacture, plate and tube rolling and drop stamping quite a large proportion of the material going through was for the motor trades. It was interesting to note to what a very considerable extent this firm has been enabled to change over from war work, although there are naturally some heavy armament departments, such as the large gun shop, which show signs of a state of peace following one of war. Although no visits were paid to any of the cutlery works, which may be said to represent the handicraft trades of Sheffield, the remarkable manual dexterity of many of the workers in the heavy trades was noted by many of the visitors. This applied particularly, for instance, to the operation of Messrs. Brown Bayley's new wire rolling mill and to the formation of hexagonal tool steel bar under the hammer in the works of Messrs. Kayser Ellison.

In the evening of Wednesday the 23rd ult. the members of the party were taken by the Local Reception Committee for a motor tour over the moors surrounding Sheffield, and on the afternoon of the following day they were entertained at a garden party at his residence by Mr. W. Clark, the managing director of Messrs. Vickers in Sheffield. Both of these functions were very enjoyable and possibly assisted members to recover from their labours of the earlier part of the day when some of them had walked no inconsiderable number of miles through various steel works. The dinner of the Institution took place in the Grand Hotel on the evening of the 24th ult. The President, Mr. Thomas Clarkson, was in the chair, and received the guests and members before the dinner. Speeches were made by the Lord Mayor of Sheffield, Mr. W. Clark, and the Vice-Chancellor of Sheffield University. A pleasing feature of the evening was the presentation of a silver cigar box to Mr. Basil H. Joy, the Secretary of the Institution, from the members. Mr. Joy had certainly worked very hard for the success of the visit and the arrangements throughout showed that he had worked effectively. We should like to add our tribute here to the very considerate and effective way in which Mr. Joy assisted us in connection with the meeting. In replying, after the presentation, Mr. Joy insisted that he had had nothing to do with the success of the Sheffield part of the visit, and put it all on to the shoulders of the Local Reception Committee, and particularly those of Captain E. W. Birch, the hon. secretary of the committee. The justice of some of Mr. Joy's assertions was recognised, and a presentation is to be made to Captain Birch by the Institution.

The last day of the meeting was devoted to an excursion to Manchester, the members leaving Sheffield at 8.32 in the morning. On reaching Manchester a visit was first paid to the works of Messrs. Crossley Motors, the members being taken from the station to the works in Willys-Overland cars. As will be generally known, Messrs. Crossley have become associated with Messrs. Willys-Overland, and the new Crossley factory at Heaton-Chapel, which was built during the war for the manufacture of aeroplanes, is to be devoted to the construction of Willys-Overland cars. After the inspection of the works of Messrs. Crossley Motors, a visit was paid to the new factory. It is a remarkably fine erection, and of its type we do not remember to have ever seen anything better. The various shops will give ample scope for the carrying out of a very large

manufacturing programme. At the present time no building is being carried out and the works are engaged in the assembling of American manufactured Willys-Overland four-seater cars. The system of assembling on a conveyor is being introduced. This system is, of course, particularly associated with the name of Ford, and it was seen in more active operation at the works of the Ford Motor Company, which were visited in the afternoon. We understand that it is the intention to manufacture the Willys-Overland car throughout at Heaton-Chapel.

After the inspection of the new factory the party was entertained to lunch by Messrs. Crossley Motors, and afterwards proceeded to the works of the Ford Motor Company, as indicated above. There was but little time to view these works, and the visit was practically restricted to a walk through the shops. These gave the visitor an impression of much activity and the division of assembling work into a number of simple operations certainly appeared to lead to a very considerable output per employee. It is probable that the conveyor system which is in use and by which the various chassis being assembled are automatically traversed from one operation to the next, has a psychological effect which tends to maintain the output of each worker. The works are devoted to assembly only except that panel work for bodies and radiation parts are being manufactured. There were signs of further machinery for this class of work being installed. The completion of this visit terminated the meeting, and the members were conveyed to the Central Station where the party broke up, the majority, however, travelling to London together. The number of members attending varied in the course of the whole excursion, but it was, we think, at all times well over one hundred.

THE NATIONAL PHYSICAL LABORATORY.

(*Continued from page* 868 *of vol. cix.*)

WE now proceed with our comments upon the demonstrations arranged for the annual inspection of the Laboratory on June 22.

Metrology. Slip-Gauge Comparator.—When illustrating the minimeter of Mr. G. M. Eden on page 34 of our issue of July 11, 1919, we mentioned that Mr. J. E. Sears, Superintendent of the Department at Teddington, had designed a modification of this machine, and this we are now able to describe as constructed in the Gauge Workshop of the Laboratory. This new 4-in. slip-gauge comparator also measures within one-millionth of an inch, and the two instruments mentioned, both in constant use, especially for the verification of Johansson gauges, show a most satisfactory accord.

The original Eden machine is provided with ball-measuring faces holding the gauge during measurement, and is suitable only for comparing flat gauges. The new machine—shown in Fig. 4—is provided with flat measuring faces, and some rather elaborate means of adjustment were required to ensure perfect parallelism of these faces. The bed of the machine (dimensions 22½ in. by 5 in.) carries two headstocks securely fixed in position. The plunger (1½ in. diameter) of the right-hand headstock is lapped to be a good sliding fit; two locking screws (not marked in Fig. 4) hold it in the bore. The face of the plunger, ¼ in. in diameter, is one of the measuring faces; it is lapped in a special jig to be quite flat and square to the plunger axis. The base of the left-hand headstock supports the barrel above by flexible steel strips at each end, these springs forming one of the characteristic features of Mr. Eden's designs. This mode of support allows the barrel to move slightly endways, its axis remaining parallel to itself. The barrel is bored to carry a spindle, the right-hand end of which forms the second measuring face. At this end of the spindle there is also a spherical shaped collar which rests on a bevelled facing at the end of the barrel, contact being maintained by a spring inside the barrel. The latter is bored to clear the spindle, the tail end of which is held between the points of two pairs of set screws placed at right angles and screwed into tongues at the rear end of the barrel. By this squaring adjustment the spindle can be tilted on its spherical setting to ensure parallelism of the measuring faces within 0·000001 in. The adjustment has to be very sensitive, and this is provided for by the springing action of the four tongues in which the set screws are mounted.

The pressure between the measuring faces is derived from adjustable weights suspended by a rod which is coupled to two bell-crank levers mounted one on each side of the barrel. To open the measuring faces when inserting a gauge the barrel is moved slightly to the left on its flexible springs by means of a lever (not marked in Fig. 4), in front of the left headstock, this lever being connected to a spindle carrying an eccentric disc which bears against a stop fixed to the lower part of the barrel. Having inserted the gauge the operator turns the lever, to disengage the eccentric; the action of the weights then brings the measuring face on the left into contact with the gauge and holds the latter suspended between the two faces.

When two gauges of approximately the same length are to be compared by the machine, they are inserted in turn, and it is the function of

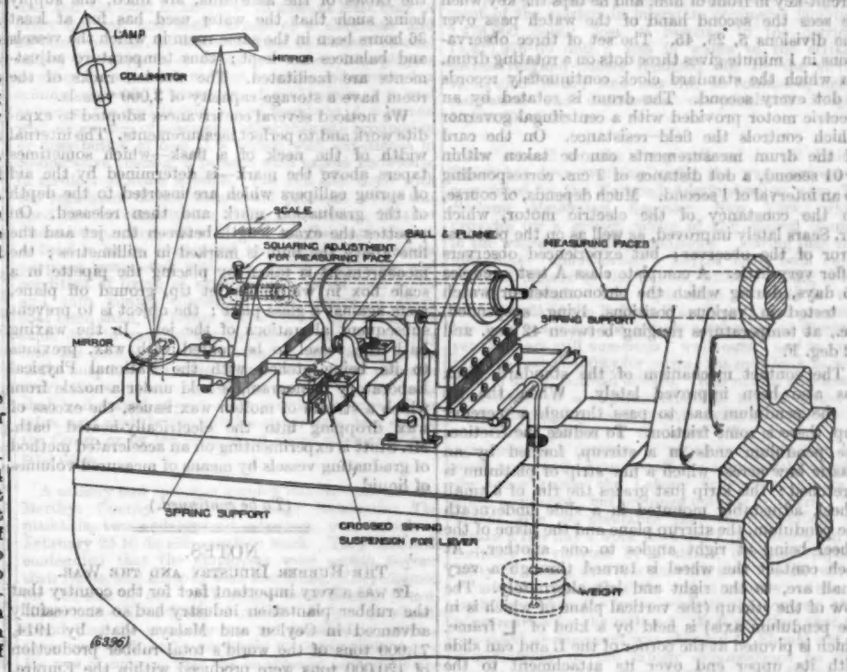


FIG. 4.

the indicating gear to register the relative displacement between the two settings of the left-hand measuring face or the barrel to which it is fixed. The magnification by this gear of the small displacement is both by mechanical and by optical means. Mechanically by a 10 : 1 lever which—not to introduce friction or backlash—is not supported on pivots, but has a virtual axis of rotation formed by the line of intersection of the planes of two pairs of steel strips, one pair horizontal, one pair vertical, fixed to the lever and to lugs on the base of the headstock. The perspective view will render this crossed-spring suspension clear. The short vertical arm of the lever is provided with a hardened steel ball point resting against a flat steel stop projecting from the barrel, the ball and plane device of the diagram. The face of this stop is vertically above the vertical axis of the lever, so that the motion is wholly of a rolling nature and sliding and consequent friction are obviated—very essential points for the correct functioning of the machine. The vertical motion of the longer horizontal arm (limited by two stops) is transmitted to a tilting mirror.

This lens-mirror consists of a plano-convex lens of 80 in. focal length, the lower plane face of which is silvered. The mirror is fixed to a thin brass disc (½ in. diameter), to the base of which three ⅛ in. steel balls are soldered, the middle one being 0·1 in. off the centre line of the two others. The middle ball rests between two (⅛ in. diameter) cylinders fixed horizontally to the end of the 10 : 1 lever, with their axes parallel to the lever; the outer balls are similarly supported on a bracket fixed to the base of the headstock. All the parts are as light as possible, and the balls and cylinders highly polished. An aluminium hood keeps the dust off the left headstock even when measuring; the beam from the pointolite lamp passes through a window in this hood. A fine wire is stretched across the lamp condenser; the lens mirror and the fixed mirror above it form an image of this wire on the opaque scale mounted at the rear of the machine. With an optical lever 132 in. in length, the total magnification obtained is $2 \times 10 \times 132/0{\cdot}1 = 26{,}400$, so that a displacement of the left measuring face through 1/100,000th moves the cross-wire on the scale through 0·25 in. The main divisions of the scale were set out by measuring standard slip gauges differing in size by 0·0001 in., and each of these divisions was afterwards subdivided into 10 parts. To realise the full accuracy of one millionth of an inch in repetition work extreme care has to be taken as to the cleanliness of the faces and gauges and also as to the uniformity of temperature of the gauges and the machine.

Eighty-Inch Comparator.—The 80-in. measuring machine, made by the Société Genevoise, is a recent acquisition of great utility inasmuch as it allows of making comparisons between line measures and end measures. The machine, at present temporarily set up, is a bench on which a long carriage bears the microscopes and one of the measuring faces, and a short carriage supports a micrometer with the second measuring face in the shape of a plunger, the position of which is read off on a small wheel turning in the vertical plane of the carriage axis; two further carriages act as supports. The usual standard is a metre bar.

The 50-m. Bench. Magnetometer Cylinder.—The determinations, interrupted by the war, of the constancy of the 50-m. bench, have been resumed, and they show that the bench has grown by about ¼ in. since 1915. Tapes under measurement at this bench used to be loaded at both the ends. The corridors at the ends of the bench passage were hardly used before the war, but the one corridor has become a much frequented gangway over to the new buildings, and this traffic interfered with the free tape suspension at the one end. Mr. Sears has hence put up a simple tension gear for suspending and for shifting the tape at this end. The tape is taken—under a load of 10 kg.—round a large pulley

on which it is clamped, and then passes over two smaller pulleys, the three pulleys being mounted in the framing of a bell-crank lever; none of the parts project into the corridor.

The marble magnetometer cylinder, which is now being measured by other devices of the Department, is intended for the Schuster magnetic standard. It is a hollow cylinder, more than a foot in length, provided with a circumferential groove near each end. Copper-wire coils are embedded in these grooves; these wires must be perfectly uniform and symmetrical with respect to the magnetic needle suspended in the cylinder. Each of the coils has only one layer, but the wires are in two halves, the two pairs being interconnected after the manner of a Hemholtz double galvanometer.

Rating of Clocks and Watches.—The rating of clocks and watches is conducted in Bushy House, where the departments for Electricity (apart from Electrotechnics), Heat and Radium are still housed. The rating is done by Mr. E. G. Constable in the following way: The observer has the watch and a circuit-key in front of him, and he taps the key when he sees the second hand of the watch pass over the divisions 5, 25, 45. The set of three observations in 1 minute gives three dots on a rotating drum, on which the standard clock continuously records a dot every second. The drum is rotated by an electric motor provided with a centrifugal governor which controls the field resistance. On the card of the drum measurements can be taken within 0·01 second, a dot distance of 2 cm. corresponding to an interval of 1 second. Much depends, of course, on the constancy of the electric motor, which Mr. Sears lately improved, as well as on the personal error of the observer; but experienced observers differ very little. A complete class A test occupies 45 days, during which the chronometer or watch is tested in various positions, lying, suspended, &c., at temperatures ranging between 42 deg. and 92 deg. F.

The contact mechanism of the standard clock has also been improved lately. When the tip of the pendulum has to pass through a mercury cup, there is some friction. To reduce the friction, the pendulum ends in a stirrup, formed by an elastic bow across which a fine strip of platinum is stretched; this strip just grazes the rim of a small wheel, adjustably mounted in a slide underneath the pendulum, the stirrup plane and the plane of the wheel being at right angles to one another. At each contact the wheel is turned through a very small arc, to the right and left alternately. The bow of the stirrup (the vertical plane of which is in the pendulum axis) is held by a kind of L frame, which is pivoted at the corner of the L and can slide with its upper end over its attachment to the pendulum, so that it may rotate slightly. The case of the standard clock is sealed hermetically, the air pressure inside is about 27 in. of mercury; the whole front of the case is glass. Time signals are received from Greenwich and by (radiotelegraphy) also from the Eiffel Tower.

Glassware. Volumetric Testing.—The section for the testing of scientific glassware under Mr. V. Stott, was, on the inspection day, found established in its spacious new house near the administration building, which it has occupied for about three months. Half of the ground floor is taken up by the packing room, which is provided with a ware-lift. On the first floor is the large well-lighted room in which glass vessels are standardised in litres and kilogrammes or in gallons and ounces with the aid of balances especially made by Messrs. Oertling to the design of the Laboratory.

The counterpoise method of weighing by these balances is interesting. From each end of the balance beam is suspended a wire frame holding two pans (not one only) there being thus on each side an upper pan *u.p.* and a lower pan *l.p.*, and both standard weights and unstandardised weights are used. When a 1,000 cub. cm. flask F1 is to be tested, it is put on the right-hand *l.p.*, and a standard kilogramme is put on the right *u.p.*; a similar flask F2 and a weight of about 1 kg. are placed on the left pans, balance being established by adding weights to the left *u.p.* F1 is now taken off, filled with water, and replaced in its pan; the standard kilogramme is removed, and small standard weights are added to the right *u.p.* until balance is re-established. The difference in the first and second weights on the right gives the weight in air of the water in the flask. The method is independent of any inequality in the balance arms and so saves double weighing. In deducing the flask capacity account is taken of the water temperature and air density. If there were only one pair of pans the flask and the standard weight would, with this convenient method of counterpoising, have to stand on the same pan, which would make the pan hang out of the vertical. The separate pans for the vessels and the weights avoid this. It is curious that within the last few days only it was discovered that a similar four-pan balance, dating from 1825, is in the Standards Department of the Board of Trade.

The load capacities of these Laboratory balances range from 3 kg. down to 250 grammes, the latter weighing to 0·1 milligramme. All the distilled water required is taken from a tank fixed in the room, from which the large glass jars, placed above the tables of the assistants, are filled, the supply being such that the water used has for at least 36 hours been in the same room in which the vessels and balances are kept; thus temperature adjustments are facilitated. The wooden racks of the room have a storage capacity of 3,000 vessels.

We noticed several contrivances adopted to expedite work and to perfect measurements. The internal width of the neck of a flask—which sometimes tapers above the mark—is determined by the aid of spring callipers which are inserted to the depth of the graduation mark and then released. On pipettes the exact length between the jet and the line above the bulb is marked in millimetres; the measurement is taken by placing the pipette in a scale box in which the jet tip, ground off plane, rests against a glass plate; the object is to prevent subsequent alterations of the jet. In the waxing bath the vessel to be coated with wax, previous to its being etched with the National Physical Laboratory monogram, is held under a nozzle from which a stream of molten wax issues, the excess of wax dropping into the electrically-heated bath. Mr. Stott is experimenting on an accelerated method of graduating vessels by means of measured volumes of liquid.

(To be continued.)

NOTES.

THE RUBBER INDUSTRY AND THE WAR.

IT was a very important fact for the country that the rubber plantation industry had so successfully advanced in Ceylon and Malaya that, by 1914, 71,000 tons of the world's total rubber production of 120,000 tons were produced within the Empire, and that Liverpool and London were the chief distributing centres for rubber. The British rubber manufacturers themselves consumed only 18,000 tons of rubber, whilst, according to Mr. B. D. Porritt (*Journal Society Chemical Industry*, June 15) Germany and Austria together only wanted 14,000 tons of rubber annually. There was the further significant circumstance that, in return for adequate rubber supplies and unrestricted export facilities to all parts of the Empire, America undertook not to export any rubber raw materials or manufactured goods to enemy countries. On the other hand the war naturally increased the demand for rubber very much on the part of the Allies. Substitutes were needed for hard rubber products like vulcanite and ebonite; stabilit had to be replaced for magnetos; aircraft and submarine craft could not do without rubber. The trench warfare necessitated soft rubber ware in enormous quantities; one firm alone supplied 60,000 pairs of trench boots per month, and the Scottish rubber footwear totalled 1,500,000, it is estimated. The demand for rubber hose, for dealing with both water and poison gas, for gas masks, &c., also swelled to amazing dimensions. That the same applies to surgery articles need hardly be said. One firm supplied 20,000 camp sheets per week, some 2,000,000 altogether. As regards the automobile industry Mr. Porritt had not been able to obtain any statistics; but the figures must have been enormous, and what traction needed in one way, transmission of news across the vast areas of the war by telegraph and telephones, by balloons, &c., required in another way in insulating material. The production of balloon fabrics, formerly a speciality of a few European firms, became an important branch of the trade. One British firm was for two years gas-proofing sufficient material to construct twenty-five kite balloons per week, the output representing a yearly production of 1,200 miles of pieces from 50 yards to 100 yards in length, all carefully to be tested for weight, strength and permeability. One of the results of the scientific investigations was the discovery of a method for prolonging the effective life of the rubber used in the fabric for retaining the gas; this is important for the development of aeronautics in tropical countries. There were plenty of other new problems for the rubber manufacturer. For though the supply of crude rubber was never seriously jeopardised, some of the indispensable ingredients, barytes, zinc oxide, pigments, &c., became very scarce, or failed altogether, and Mr. Porritt remarks that it would be idle to contend, that even after five years the wares compare as a whole with the pre-war standard of quality.

STATE AID FOR CIVIL AVIATION.

Although it seems now to be generally admitted that some form of State assistance in the development of civil aviation is essential, there is, as might be expected, considerable divergence of views as to what form such assistance should take and what its extent should be. The majority report of the Advisory Committee on Civil Aviation, recently issued, recommends that direct financial assistance, limited to a maximum of £250,000 within the next two financial years, should be granted to aerial transport companies operating on approved routes, the grants being calculated on the basis of 25 per cent. of the gross revenue of each company earned by the carriage of passengers, mails or goods. The approved routes are London-Paris and London-Brussels, with possible extensions in each case, and another route, such as between England and Scandinavia, on which boat seaplanes, or amphibious machines, can be employed. It is not, at present, intended to make a grant for air services confined to this country only. Such, in brief outline, are the proposals of the majority of the committee, and they would, probably, be of great assistance to the industry; they certainly would not materially affect the financial stability of the nation. They have, however, some drawbacks to which attention is called in a minority report by Air Marshal Sir Hugh Trenchard, Chief of the Air Staff. While agreeing, if subsidies are granted, with the system of applying them indicated above, Sir Hugh is of the opinion that the fundamental objections to the principles of subsidies have not been sufficiently considered by the committee. That there are objections to subsidies will be generally admitted, but, in our view, such objections are less serious than the alternative possible collapse of the industry. Civil aviation, Sir Hugh considers, has not yet had sufficient time to prove its value with the indirect assistance received so far, but in this matter it appears to us that the subsidies suggested would "save the steed from starving while the grass grew." We can see no insuperable difficulty, such as Sir Hugh anticipates, in withdrawing the subsidies as soon as they can be dispensed with. We are, however, in complete agreement with that part of the minority report which recommends the retention of the services of some of the actual designers of air craft who did invaluable service to the nation during the war. That such men should carry their special knowledge to foreign countries, or that their activities should be directed into other channels, is a circumstance which could be avoided at a very trifling outlay, and it is regrettable that the recommendations of the majority report make no provision for this. Air Marshal Trenchard also considers that the sum recommended for subsidies to aerial transport companies would be better spent on design and research, by placing more orders for experimental machines with approved manufacturing concerns. Such work is undoubtedly of the utmost importance to the nation, as well as to the aviation industry, in that it would tend largely to improve existing designs and so enable us to retain the leading position held at the termination of the war. We therefore only differ from Air Marshal Trenchard

in hoping that such orders will be placed, not instead of the subsidies, but in addition to them. In urging this we by no means lose sight of the present pressing need for national economy, but when we compare the continuous expenditure on, say, labour exchanges with that temporarily necessary to establish the aviation industry on a firm foundation it really seems as if economy could be more effectively practised in other directions.

IMPERIAL WIRELESS COMMUNICATION.

We dealt briefly on page 351 of our last volume, under the above title, with the scheme for an Imperial wireless chain submitted by Marconi's Wireless Telegraph Company, Limited, to the sub-committee dealing with Imperial wireless communications. There has now been issued the report of the Imperial Wireless Telegraphy Committee. This committee was appointed on November 24, 1919, by Viscount Milner, and its chairman is Sir Henry Norman, Bart., M.P. It recommends the establishment of a scheme of Imperial wireless communications connecting the communities of the Empire by geographical steps of about 2,000 miles each, the system employed being that involving the generation of radio-telegraphic energy by thermionic valves. The service of communication between Leafield and Cairo, by Poulsen arcs, shortly to be in operation by the Post Office, would be the first link in the chain of communication with the British communities in Africa; this communication would be continued by a valve station established near Nairobi, in East Africa, the ex-German station at Windhuk being transformed into a valve station, thus completing the connection with the Union of South Africa. The distance from England to Cairo is 2,239 miles, that from Cairo to Nairobi is 2,190 miles, Nairobi being at a distance of 1,923 miles from Windhuk. For communication with India, the Far East and Australia, additional valve stations would be erected in England and at Cairo; one would be erected at Poona, a distance of 2,793 miles from Cairo; one at Singapore, a distance of 2,344 miles from Poona; one at Hongkong and one at Port Darwin, at distances of 1,611 and 2,021 miles respectively from Singapore. An alternative would be the erection of a station at Perth, a distance of 2,430 miles from Singapore. The report also suggests a valve station at Bathurst, West Africa, a distance of 2,779 miles from England, and one at Baghdad, a distance of 793 miles from Cairo. Similar communication by valve stations are proposed between England and Canada, subject to decision in conference between the Imperial and the Canadian Governments. The report further proposes that the stations be planned by a Wireless Commission of about four members, whose functions would probably cease with the completion of the stations; the construction of these latter would be entrusted to the Engineering Department of the General Post Office of the corresponding Dominion and Indian authorities, according to plans furnished by the Wireless Commission. "So far as it can judge, the scheme proposed by the Marconi Company," referred to above, the Imperial Wireless Telegraphy Committee reports adversely upon it, and adds that its own scheme would afford reliable, expeditious and economical communication for commercial, social and press purposes throughout the Empire, and that it would meet essential Imperial strategic requirements. Estimates of revenue and expenditure drawn up by the committee in connection with its own scheme point to an initial annual loss—after paying 6½ per cent. interest on capital, and allowing for complete amortisation of buildings and plant within a proper period—of about 100,000*l.* divided between the Imperial and other Governments concerned, but this loss, which, it adds, was to be expected, might reasonably be regarded as likely to decrease annually, until, after ten years, the service would show a profit. It adds that the system it recommends is probably the most economical for giving the results required; at the same time it would be in accord with present wireless science and future wireless developments, and the small temporary loss would be negligible in comparison with the Imperial benefits to be conferred. The recommendation for the use of thermionic valves was only to be expected, and all war experience points to their extended use in the future.

INDUSTRIAL NOTES.

A NEW Bill "to establish a Ministry of Mines and to regulate the coal industry, and for other purposes connected with the mining industry and the persons employed therein" was introduced in Parliament last week. The Minister of Mines is to be an additional Parliamentary Secretary of the Board of Trade, and there will be transferred to him all the powers and duties of the Board of Trade with respect to the mining industry, and all the powers of a Secretary of State under enactments relating to coal mines, metalliferous mines and quarries. During a period of one year after August 31, 1920, it shall be lawful for the Minister of Mines, subject to the approval of the Board of Trade, from time to time to give directions regulating the export of coal and the supply of coal for the bunkering of vessels, and regulating the pit price to be charged for coal sold for consumption in the British Islands and for coal sold for the bunkering of vessels. The Minister shall refer to an advisory committee for their advice any question relating to his powers and duties which appear to him of such a nature as to make such reference desirable, and shall take into consideration any representations which may be made to him by any such committee. The committee, as respects coal and the coal industry, is to meet at least once in every quarter, and shall consist of a chairman and 24 other persons, of whom 4 shall be owners of coal mines, 4 workers in or about coal mines, 3 employers in other industries, 3 workers in other industries, 1 a mining engineer, 2 managers of coal mines, 1 a coal exporter, 1 a coal factor or coal merchant, 1 a person with experience of commerce other than the production or distribution of coal, 1 a person with experience in co-operative trading, 3 persons with expert knowledge of medical or other science. The Bill also deals with the regulation of coal mines and provides under this head for the constitution of Pit Committees, District Committees, Area Boards and a National Board. A fund is to be constituted to be applied to various purposes connected with the social well-being and condition of living of workers in or about coal mines and with mining education. The owners of every coal mine shall, as before March, 1921, and before the same day in each of the subsequent five years, pay into the said fund a sum equal to one penny a ton of the output of the mine during the previous calendar year, the sums so payable in respect of any mine shall be defrayed as part of the working expenses of the mine, and shall be recoverable either as a debt due to the Crown or by the Minister of Mines summarily as a civil debt.

A colliery test case was decided last Saturday at the Merthyr County Court by Judge Rowlands. The plaintiffs, two underground labourers, were asked on February 25 to do some surface work. They declined, contending that the employers were acting beyond their rights, and the men were sent home. They claimed for the loss of one day's wages from Messrs. Guest, Keen and Nettlefolds, Limited. Judge Rowlands found that the company was not justified in sending these men back, and accordingly must pay their wages. He was of opinion that the emergency arising for the substitution of the labour of the two plaintiffs could not, in the legal sense of the term, be regarded as reasonable, and that it was largely of the employers' own creating. He could not help thinking that if both sides had been a little more reasonable the contentions would not have arisen.

The twenty-first annual report of the General Federation of Trade Unions marks, as will be seen, the majority of that body. There were 1,700 unions in existence in 1899, when the federation was formed. Only 43 joined the federation, with a membership of 343,000. The number of societies now affiliated is 134, with a membership of 1,480,108. The total income for the year was 94,534*l.*; of this 83,955*l.* was derived from entrance fees and contributions, the balance, 10,579*l.*, was mostly from interests on investments. The reserve fund, which in March, 1919, stood at 254,266*l.*, now stands at 120,393*l.*, a decrease of 133,873*l.*

When Congress reconvenes it will give further consideration to the question of anti-strike legislation, says *The Iron Age*, New York. The Poindexter Bill, prohibiting interference with commerce by strikes, which was the subject of hearings before the Senate Committee on Inter-State Commerce recently, has reached the Senate calendar and presumably will be pressed at the next session. The Bill when originally introduced was aimed to apply to all those "employed in any capacity in the production, care, maintenance, or operation of any means or agency of such commerce." It was intended that the Act would apply as well to industries engaged in the production of cars, locomotives, necessary fuel, and other means and agencies of transportation. The committee, however, restricted the operation of the first section of the Bill to the officers and employees of carriers subject to the Act to regulate commerce, for the reason that to them only had means been provided for the adjustment of industrial disputes by an official tribunal of the Government. The first section of the Bill provides a fine of not exceeding 10,000 dols. or imprisonment of not exceeding ten years upon whosoever advises or attempts to persuade persons employed by carriers to obstruct, delay, hinder, or prevent the movement of commodities. Section 2, which is not limited to employees of carriers subject to the Act to regulate commerce, but applies as well to employees of related industries, prohibits obstructing or hindering the movement of commodities by force or violence or by threats or menace of any kind. The first section applies only to peaceable efforts to tie up transportation.

The coastwise steamship lines, which are under the jurisdiction of the Inter-State Commerce Commission, would be affected by the anti-strike Bill. Shipping men who appeared before the committee estimated that from January 1, 1918, down to the present time the strikes in coastwise shipping lines have cost the public 85,959,976·69 dols. This includes interest on the investment of the shippers in the commerce tied up at 6 per cent., 12,800,000 dols.; interest on the investment of the carriers in interstate commerce facilities, 2,478,000 dols.; loss of revenue to the carriers, 18,426,976·69 dols.; loss in wages to the strikers themselves and others rendered idle by the strike, 12,255,000 dols.; and loss due to confusion, delay, congestion and destruction of perishable freight, 40,000,000 dols.

For several months every railroad in the United States has been working under the wage agreement negotiated by the Railroad Administration, says *The Railway Mechanical Engineer*, New York, which provides for a written notice of any desired changes in the wages or working conditions. During that time numerous "unauthorised" strikes have been called by local officers of the unions, without giving notice to the railroads. The adjustment of wages is now in the hands of the Federal Wage Board, and provision has been made for the orderly settlement of disputes, yet there are still numerous "walk-outs," and in every case the responsibility for getting the men back to work reverts to the railroad officers. It is not an uncommon occurrence for a superintendent of motive power to waste several days each month trying to settle strikes at isolated points on the road. The present wage agreement is a contract in which one party, the railroad, apparently assumes all the responsibilities, while the other party, the Labour Federation, exacts as much as possible, but promises nothing in return. The unions give no assurance that their members will return a fair day's work for a day's pay, and when the contract is violated by a strike, disclaim responsibility by stating that it is unauthorised. If the railroad violates its agreement the union secures redress by striking; when the union violates the contract there is no redress for the railroad. Is it not time that this one-sided arrangement was changed? Should not the responsibility of the labour organisations be more clearly defined and some provision made for holding them to the fulfilment of the obligations of their contract?

The crisis in the printing trade on which we reported in past issues came to a temporary settlement towards the end of last week when, at a meeting of the Joint Industrial Council for the Printing Industry, the following resolution was passed: "The Joint Industrial Council, having carefully considered the interests of all occupied in the printing trade, is of opinion that the employers' representatives should give an assurance to the Typographical Association that the conference shall be held, on request, after the new Rent Restriction Act becomes operative, with a view to reconsidering the position. With this assurance the Typographical Association shall agree to submit to their members the offer of 10*s.* increase. The Typographical Association shall agree that notices be suspended for one week to enable that association's executive to consult their members, and the embargo on overtime shall be immediately raised."

The resolution was unanimously agreed to by the Joint Industrial Council. The Executive Council of the Typographical Association accepted the resolution, and have promised that they will take the earliest opportunity of placing a full statement of the facts before their members. The employers' representatives also gave the necessary assurance referred to in the resolution. The settlement will date from the pay-day of the week ending June 12 in the same manner as already agreed to by the other unions, subject to ratification.

The London Master Printers' Association have addressed a letter to the members pointing out that

the general advance in wages of 10s. per week to all men, 3s. 6d. per week to qualified women workers, and 1s. 9d. per week to learners in the printing trade in London, makes it necessary for printers to increase their present charges.

It is stated that the London Costing Committee, the letter adds, have investigated the figures of a number of printing offices in London. Since the Costing Committee issued their last statement in December, 1919, there have been increases in the cost of power, rates and other general expenses, and the committee find that it is necessary for printers to increase the present charges by 11 per cent. to cover these additional costs.

This percentage applies only to printing, apart from materials, and further adjustments must be made to cover any increase in the cost of paper, strawboards, and other materials, which are rapidly increasing in price.

The above 11 per cent. is the average increase in cost in a normal jobbing printing office, but in a periodical, newspaper or other house, where the proportion of wages to general expenses and the amount of overtime is heavier than in an ordinary jobbing office, the increase is greater than 11 per cent.

The London Costing Committee will shortly issue revised hourly rates for London to cover the recent increases in wages.

The gas workers notices for a strike were to expire on Saturday, June 26, but a meeting was held at York on Thursday, the 24th, under the chairmanship of Alderman H. Simpson, Birmingham, there being a full attendance of representatives of all the trade unions concerned in the dispute. Captain J. O'Grady, M.P., secretary of the National Federation of General Workers, and Mr. A. Hayday, M.P., secretary of the National Joint Industrial Council for the gas industry, acted as joint conference secretaries. The following resolution was adopted: "In view of the employers' offer of 1s. per day or shift, to date from June 1, 1920, this conference agrees to the suspension for one week of the notices to cease work, and that a negotiating committee be appointed to continue the discussion with the employers' representatives on all the points of our claim."

At a mass meeting of Sheffield gas workers held on Friday, June 25, the above resolution was warmly discussed, and, at first, the men were in favour of an immediate stoppage. Later on, however, the following resolution was carried: "That this meeting emphatically protests against the delay in settling our claim, and will not agree to any further suspension of notices beyond July 3. It further expresses itself emphatically of the opinion that the present offer of the employers is hopelessly inadequate, and will not bind itself to accept any settlement that has not been submitted to the members for their approval."

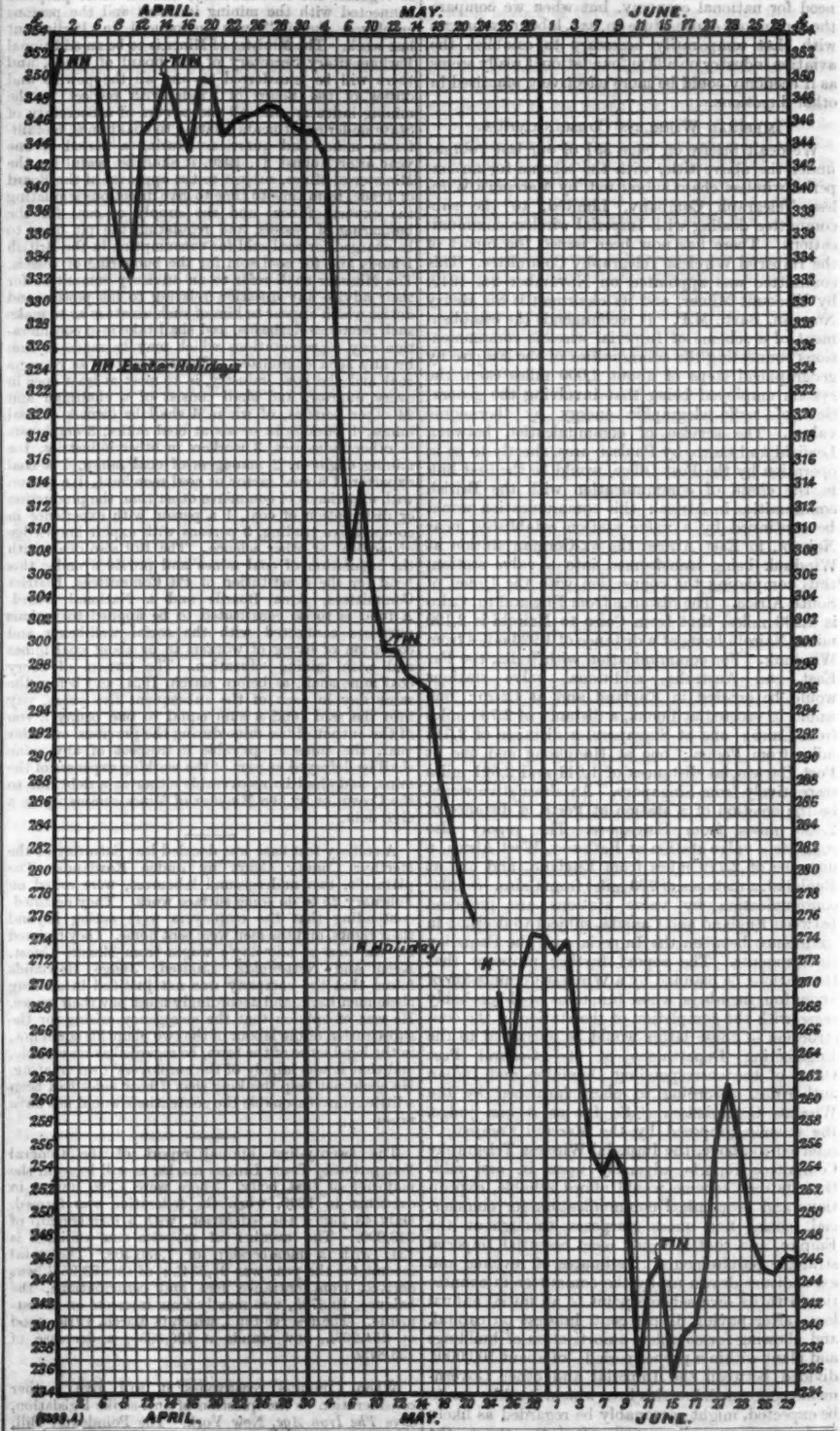
A meeting was held in London last Tuesday, at which over forty trade unions of both skilled and semi-skilled workers in the foundry, engineering, shipbuilding, and ship repairing trades were represented, when further advances were demanded in both time and piece rates.

PERSONAL.—The Research Association of British Rubber and Tyre Manufacturers, 11, Ironmonger-lane, E.C. 2, state that they have secured laboratory accommodation at the Chemistry Department of University College, Gower-street, W.C. 1.—In order to deal more conveniently with his consulting work in the Lancashire district, Mr. C. H. Wordingham, C.B.E., M.Inst.C.E., has taken offices at 11, Mosley-street, Manchester.—The Directors of the Vulcan Boiler and General Insurance Company, Limited, have accepted with regret the resignation of the managing engineer, Mr. C. Bullock, after 44 years' service. Mr. Frank H. Bullock, Assoc. M.Inst.C.E., M.I.S.Inst., Deputy Managing Engineer, has been appointed to the position of managing engineer as from July 1.

UNIFICATION OF ELECTRIC SUPPLY POTENTIAL IN SWITZERLAND.—Two June meetings of the Swiss Elektrotechnische Verein and of the Vorband Schweizer Elektrizitätswerke have practically agreed upon the low-pressure volts for the Swiss electricity supply. Two series of potentials had previously been proposed: I, alternating currents at 125 volts, 220 volts, or 350 volts, and direct currents of 110 volts, 220 volts, 440 volts; II, alternating currents at 145 volts, 250 volts, 440 volts, and direct currents at 125 volts, 250 volts, 500 volts. The selection of either series was, it had been agreed, to be left to the electricity works, since the financial problems would be the most serious ones. The majority in favour of series I was not large, but series I was finally adopted unanimously by both the bodies mentioned. These pressures are hence declared normal, and it is recommended that new works be constructed, and old plants extended, only on these potentials, and that old supply systems be adopted to the new standards. The potentials are understood to be the volts at the terminals of the users, under normal load; as regards power transmission lines further rules are to be issued.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.

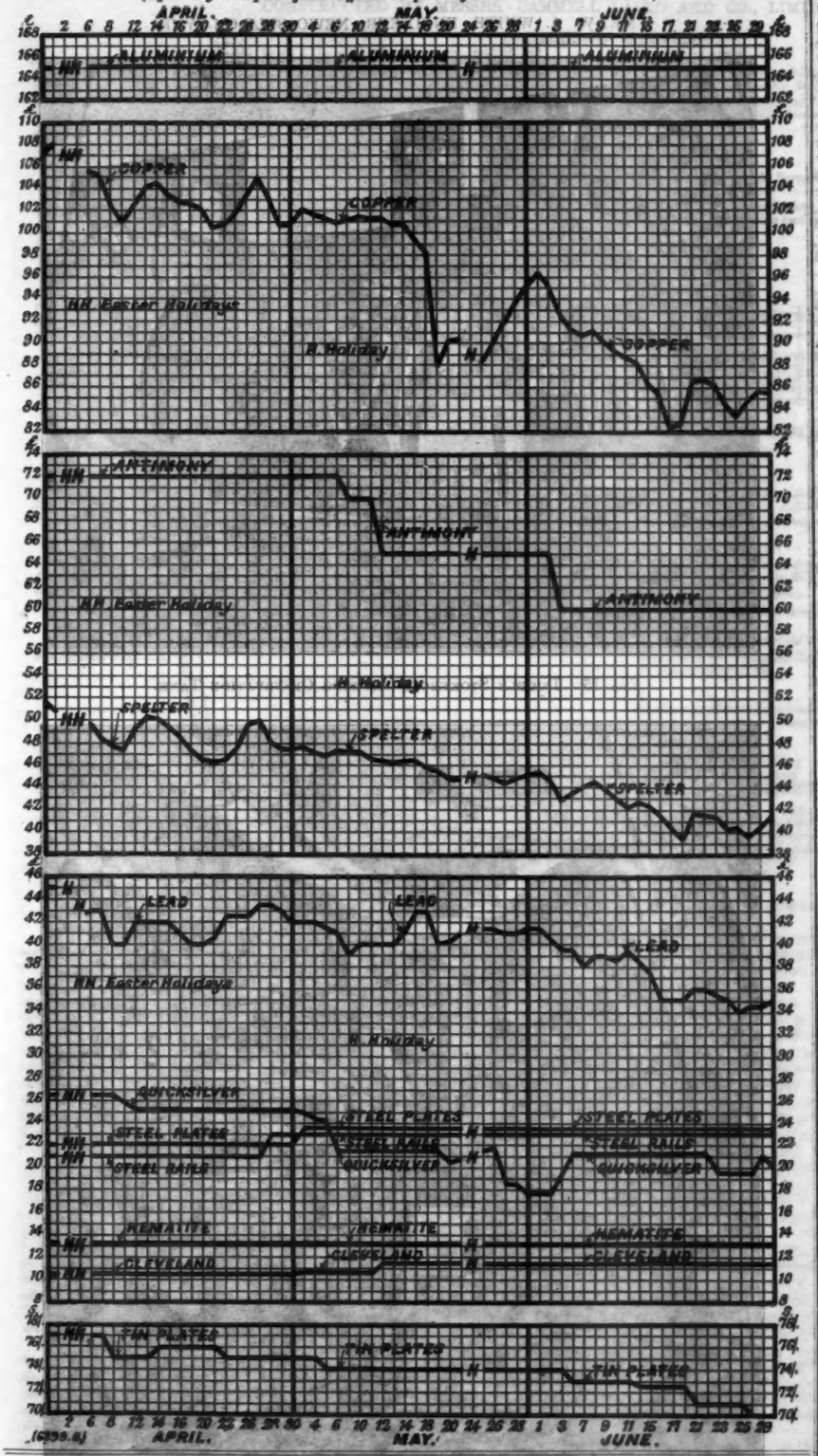
(Specially Compiled from Official Reports of London Metal Markets.)



NOTE.—In the diagrams the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange for fine "foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. Middlesbrough prices are plotted for steel plates and rails, and also for hematite and Cleveland pig-iron. The prices given, in the case of steel plates are for ship, bridge and tank qualities, and those for steel rails are for heavy sections. The pig-iron prices are for East Coast hematite and Cleveland iron, both of No. 1 quality and for home consumption. The price of tin-plates is per box of I.C. cokes free on board at Welsh ports, but in all other cases the prices are per ton. Each vertical line in the diagram represents a market-day, and the horizontal lines represent 1*l.* each, except in the case of the diagram relating to tin-plates, where they represent 1*s.* each.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal Markets.)



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NATIONAL ILLUMINATION COMMITTEE OF GREAT BRITAIN.—A meeting of this committee was held on June 21, to consider various subjects, including the resignation of the chairman, Mr. A. P. Trotter, on account of his retirement to the country. Mr. Trotter's resignation was received with great regret, and Major Kenelm Edgcumbe (vice-chairman), was proposed as his successor. Major Kenelm accepted the position, and is now chairman of the committee.

THE PEAT RESOURCES OF IRELAND.—The Department of Scientific and Industrial Research, 16 to 18, Old Queen-street, Westminster, S.W. 1, has recently published at the price of 9d. net, a pamphlet reproducing a lecture given before the Royal Dublin Society, on March 5, 1919, by Professor Pierce F. Purcell, A.M.Inst.C.E., on "The Peat Resources of Ireland." It deals in detail with the physical properties of the peat, its winning and treatment, and its uses.

THE WHITE OIL-FUEL SYSTEM.

WE have already referred, on pages 832 and 865 of our last volume, to the oil-fuel installations recently completed on the Cunard liner Aquitania and the White Star liner Olympic, and have given general particulars of these installations in both cases. We are now able, by the courtesy of the inventor, Mr. W. A. White, of Pearl Buildings, Newcastle-on-Tyne, to reproduce drawings of the essential details of the system on Plate III which accompanies this issue. We also reproduce some photographs of the Aquitania installation on page 24 and Plate IV.

A longitudinal section and end elevation of the burner are reproduced in Figs. 1 and 2, respectively, while Fig. 3 is a section of the nozzle drawn to a rather larger scale in order to illustrate its construction more clearly. As mentioned in the two articles above referred to, the oil in the White system is forced into the burners at the comparatively low pressure of from 60 lb. to 90 lb. per square inch, and sprayed by mechanical action only. The method of effecting the spraying will be clear from an examination of Figs. 1 and 3. The oil passes along the central tube of the burner into a cylindrical space containing a body resembling a mushroom valve. The latter is pressed into contact with the nozzle by means of a helical spring, so that the oil is forced to flow through three grooves in the valve seat into a small conical space immediately behind the outlet opening of the nozzle, and the three jets meeting in this space are thus broken up into a fine spray. The nozzle itself is screwed on to the burner body and can easily be removed for cleaning, an operation which is usually carried out about once in every 12 hours in normal working; it can also be exchanged for one with a larger or smaller opening if it is desired to vary the oil consumption materially. A removable strainer for retaining any foreign matter will be noticed on the left of Fig. 1. The burner, of course, fits into the central tube of the furnace front shown in section in Fig. 11. It is held in position by means of a swinging shackle pivoted to a gun-metal casting which is screwed into the furnace front. The joint between this casting and the burner is of the spherical metal-to-metal type, and it is kept tight by a pointed set screw carried by the swinging shackle. By slacking back this set screw and swinging the shackle clear, the burner can be taken out in a few minutes for cleaning or examination.

On its way to the burner the temperature of the oil is raised several degrees above its flash-point, which for the Mexican petroleum residue used on the Aquitania and Olympic is about 168 deg. F., by passing through the steam heaters illustrated in Figs. 4, 5 and 6. The longitudinal section, Fig. 4, it should be explained, has been drawn horizontally for convenience, but, in practice, the heaters are placed vertically, the right-hand end of Fig. 4 being at the top. The heater comprises a cast-iron body with a cover fastened to the upper end by means of studs, and it contains two concentric coils of seamless steel tubing, the arrangement of which can be followed from Figs. 4 and 6. The four ends of the coils pass through stuffing-boxes in the cover to a yoke-piece supported by pillars screwed into the cover as shown on the right of Fig. 4, and also in Fig. 5. The tubes enter the yoke-piece through stuffing-boxes, so that the former can expand or contract without restraint. The oil inlet and outlet pipes are connected to the yoke-piece by flanges, and the oil after passing through one of the coils returns to the yoke-piece and travels through a short passage in this to the other coil, and thence through the outlet to the burners. Steam is admitted to the heater through a connection in the bottom, shown in Figs. 4 and 6, and it leaves through an outlet in the cover seen in Fig. 5.

Throughout the whole of the installation every possible precaution is taken to prevent foreign matter, which might clog the burners, from reaching them, strainers being fitted at the filling connections on the side of the vessel and also on the suction and delivery sides of the fuel pumps, as well as on the burners themselves, as mentioned above. Figs. 7 and 8 illustrate the fuel-pump suction strainers, through which the oil is drawn from the settling tanks. As will be seen from the drawings, which are practically self explanatory, the strainer is of the twin type, so that one part can be opened up for cleaning while the other is at work. The body of the strainer is of cast-iron with covers, of the same material, held in place by a quickly-detachable yoke. Oil enters through a flanged connection in the upper part of the body and leaves through a similar connection at the bottom, passing on its way through a perforated basket of galvanised steel. This basket is bolted to a wrought iron sleeve provided with a straight handle by which the basket can be lifted out for cleaning. The holes in the baskets are 0·06 in. in diameter and there are 100 of them per square inch of surface. These strainers are tested to 200 lb. per square inch before delivery. The discharge strainers illustrated in Figs. 9 and 10

are fitted between the heaters and the burners. Their construction is very similar to that of the suction strainers, the main differences being that they are made stronger to withstand the higher working pressure, and that the covers are held in place by studs. The baskets are also of a finer mesh, there being 120 holes per square inch, and each hole being 0·055 in. in diameter. The test pressure for these strainers is 420 lb. per square inch, and the working pressure is, normally, 75 lb. per square inch.

The details so far dealt with are common to both the Aquitania and Olympic installations, but the furnace front illustrated in Figs. 11 and 12 applies to the Aquitania only, since the Howden system of forced draught is employed on that vessel, whereas the Olympic works with natural draught. In the Howden system, it will be remembered, the air for combustion is forced through tubular heaters in the uptakes from the boilers, and delivered to the furnaces through trunks fitted to the fronts of the boilers. The furnace front illustrated is used with this system on the Aquitania, and Fig. 12 shows, dotted, the spiral guides employed to give the air a rotary motion. The air supply can be regulated by the handle shown near the top of Fig. 11, and a conical baffle fitted round the tube containing the burner will be noticed in the same illustration. The position of this baffle can be adjusted by pulling or pushing the rods passing through the front casting. In the Olympic installation the air enters the furnace from the stokehold through a furnace front of special design, its temperature being raised considerably in passing through passages formed in the front casting. The arrangement also serves to reduce the temperature of the stokehold by carrying off heat which would otherwise be radiated.

In Figs. 13 and 14, on Plate IV, and Figs. 15 and 16, annexed, we reproduce some photographs of the stokeholds of the Aquitania taken after the oil fuel installation had been completed. To enable these illustrations to be followed we may again explain that the boiler equipment of the vessel comprises 21 double-ended boilers, with eight furnaces each, arranged in seven groups of three abreast. There are six boilers in each of three forward boiler rooms, which are separated by two athwartship oil bunkers and the third athwartship bunker is situated at the forward end of the first of these boiler rooms. Another boiler room, at the after end of the series, contains three boilers. There are thus a double stokehold and two single stokeholds, in each of the three forward boiler rooms, and two single stokeholds in the after boiler room. Two views of one of the double stokeholds looking in opposite directions are given in Fig. 14 on Plate IV, and Fig. 15 annexed. In the latter of these a small rectangular tank, with a circular opening in the top closed by a cover secured by swinging bolts and flynuts, will be noticed. This is the observation tank to which the traps draining the heating coils in the bunkers are connected, and its object is to enable any leakage of oil into the coils to be detected. Without this arrangement, oil mixed with the condensed steam might find its way into the reserve feed tank and be pumped back into the boilers. The other view of this stokehold, Fig. 14, shows in the background, the oil transfer pumps, which are of the Weir vertical direct-acting type. Fig. 16, on this page, is a view of one of the single stokeholds showing the boiler fronts on the left and a transverse bulkhead on the right. One of the horizontal fuel pumps is visible in the foreground. Another similar view of a single stokehold is reproduced in Fig. 13, on Plate IV, in which the shallow trays, partially filled with sand and placed under the furnace fronts to collect any oil which may leak from the connections, are prominent features. In this connection it may be mentioned that a complete installation for fire extinction by means of frothy liquid has been fitted by Foamite Firefoam, Limited, of 4, Broad-street-place, London, E.C. 2. The installation includes both fixed containers for the special fluids connected to the stokeholds, and other places, by means of pipes, and portable appliances placed in convenient positions for dealing with minor outbreaks. One of these portable appliances is partly visible near the left hand bottom corner of Fig. 13, on Plate IV.

In conclusion it may be remarked that the photographs from which our illustrations were reproduced were certainly taken when the boilers were out of action, but the appearance of the stokeholds is very little different when the ship is steaming at full speed. The comparative comfort and cleanliness of the stokeholds with oil-fuel firing, as compared with coal, would be almost sufficient justification for the use of the former. The fitting of two such important vessels as the Aquitania and Olympic with the White oil-fuel system is a matter on which the inventor must be congratulated, and it also indicates that the directors and superintendent engineers of both the Cunard and White Star lines entertain no doubts as to the economy and efficiency of oil fuel.

OIL FUEL INSTALLATION ON THE "AQUITANIA."

MR. W. A. WHITE, ENGINEER, NEWCASTLE-ON-TYNE.

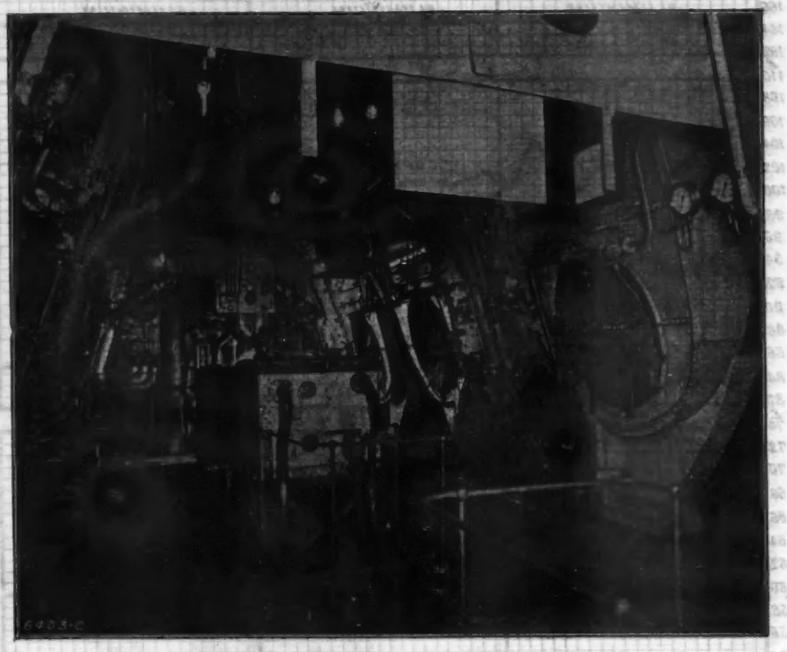


FIG. 15. DOUBLE STOKEHOLD SHOWING OBSERVATION TANK.

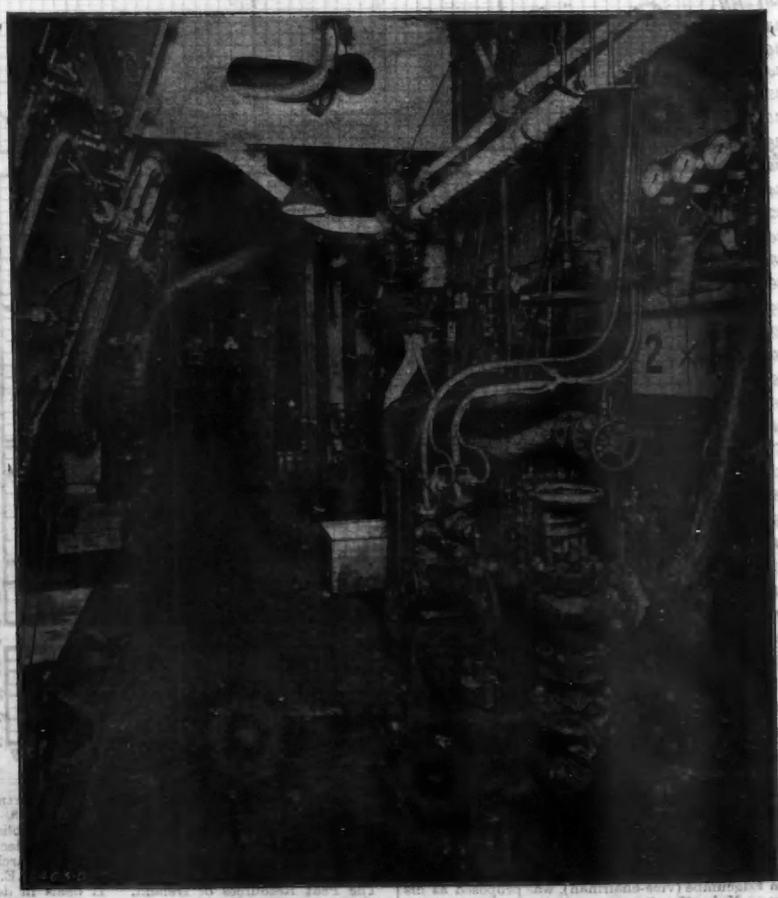


FIG. 16. SINGLE STOKEHOLD SHOWING FUEL PUMP.

THE ELECTRICALLY-WELDED SHIP "FULLAGAR."

CONSTRUCTED BY MESSRS. CAMMELL LAIRD AND CO., LIMITED, BIRKENHEAD.

MIDSHIP SECTIONS.

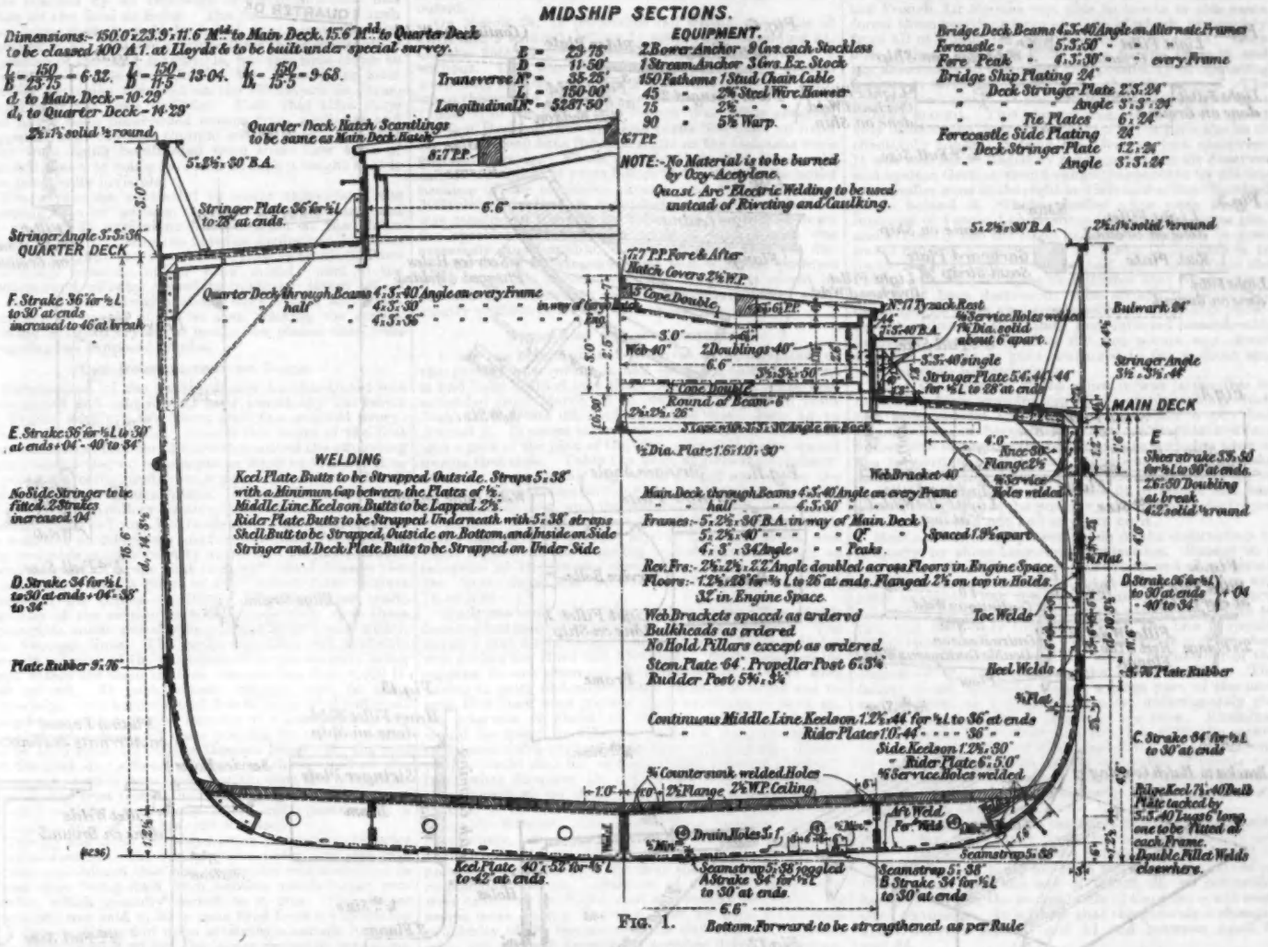

Dimensions:- 150.0'x 23.9'x 11.6' M.d to Main Deck. 15.6' M.d to Quarter Deck
to be classed 100 A.1. at Lloyds & to be built under special survey.
EQUIPMENT.
2 Bower Anchor 9 Cwt. each Stockless
1 Stream Anchor 3 Cwt. Ex. Stock
150 Fathoms 1 Stud Chain Cable
45 " 2¾ Steel Wire Rope
75 " 2½ " "
90 " 5½ Warp.
NOTE:- No Material is to be burned by Oxy-Acetylene.
Quasi Arc Electric Welding to be used instead of Riveting and Caulking.
WELDING
Keel Plate Butts to be Strapped Outside. Straps 5'.38" with a Minimum Gap between the Plates of ½.
Middle Line Keelson Butts to be Lapped 2'.
Rider Plate Butts to be Stapped Underneath with 5'.38" straps
Shell Butt to be Strapped, Outside on Bottom, and Inside on Side
Stringer and Deck Plate Butts to be Strapped on Under Side
QUARTER DECK
MAIN DECK
Stringer Plate 36 for ½ L to 28 at ends.
Stringer Angle 3.5.36
F. Strake 36 for ½ L to 30 at ends increased to 46 at break
E. Strake 36 for ½ L to 30 at ends +04 - 40 to 34
No Side Stringer to be fitted. 2 Strakes increased 04
D. Strake 34 for ½ L to 30 at ends +04 - 38 to 34
Plate Rubber 9'.76
Bulwark 24
Stringer Angle 3½ x 3½ x 48
E Sheerstrake 35.50 for ½ L to 30 at ends. 2'.50 Doubling at break. 4.2 solid ½ round
D. Strake 36 for ½ L to 30 at ends - 40 to 34 + 04
Toe Welds
Keel Welds
C. Strake 34 for ½ L to 30 at ends
Bilge Keel 7½.40 Bulb Plate tacked by 3.3.40 Lugs 6' long, one to be fitted at each Frame.
Double Fillet Welds elsewhere.
Keel Plate 40 x 52 for ⅝ L to 42 at ends.
Seamstrap 5.38 joggled A Strake 34 for ½ L to 30 at ends
Seamstrap 5.38 B Strake 34 for ½ L to 30 at ends
Drain Holes 3 f
Bridge Deck Beams 6.3.40 Angle on Alternate Frames
Forecastle " 5.3.30 " " "
Fore Peak " 4.3.30 " " every Frame
Bridge Ship Plating 24
" Deck Stringer Plate 2'.3.24
" " Angle 3.3.24
" Tie Plates 6.24
Forecastle Side Plating 24
" Deck Stringer Plate 12.24
" " Angle 3.3.24
Bridge Deck Plating 24
" Deck Stringer Plate 2'.3.24
" " Angle 3.3.24
" Tie Plates 6.24
Forecastle Side Plating 24
" Deck Stringer Plate 12.24
" " Angle 3.3.24

FIG. 1. Bottom Forward to be strengthened as per Rule

IN the figures on this and the next pages we give some illustrations which show the various detail methods adopted in the construction of the electrically-welded motor-ship Fullagar. This ship, as will be generally known, was built by Messrs. Cammell Laird and Co., Limited, at their Birkenhead yard, and was launched last February. She has since that time been completed and has carried out very successful trials. The type of construction adopted has proved in every way satisfactory. The boat is fitted with a Cammell-aird-Fullagar opposed-piston oil engine of about 450 brake horse-power and working on a single screw, she is thus unique not only in virtue of her welded construction, but also on the score of her propelling machinery. This constitutes the first application of the Camellaird-Fullagar engine. It is interesting to note that it was at one time intended to fit the Fullagar with a Kitchen rudder. This idea was abandoned not owing to any lack of faith in the rudder, but because it was considered undesirable to incorporate too many novel features in the one ship. The absence of a Kitchen rudder certainly makes the installation a more effective test of the Camellaird-Fullagar oil engine. This engine we need not refer to further here, as it was very fully dealt with by us in a recent issue.*

The Fullagar is a coaster, 150 ft. long by 23 ft. 9 in. beam and 11 ft. 6 in. deep to the main deck. The draught is 11 ft. 4 in. and the deadweight about 500 tons. The cargo capacity is 25,200 cub. ft., and the speed 9½ knots to 10 knots. There is one long hold with two hatches and the propelling machinery is aft with side oil bunkers. The crew is accommodated in the forecastle, the captain and mate amidships on the bridge, and the engineers in rooms arranged in the casing. The boat has two masts, four derricks and three winches. An oil-fired donkey boiler is fitted for supplying steam to the latter. As will be seen from this brief description, the boat is in no way a freak craft. In form and appearance she is a very ordinary coaster, and will without doubt slip easily into her place in service with the fleet of her owners, Messrs. T. and J. Brocklebank, Limited, of Liverpool.

It should be made clear that the Fullagar is an entirely welded ship. There is not a rivet in her from one end to the other. To build such a ship was perhaps to some extent a *tour de force*, but the proceeding was unquestionably the best from the point of view of demonstrating the suitability of electric-welding for ship construction. The success of the Fullagar has shown that welding is effective for all the purposes of such work. This, however, is not to say that it is necessarily the cheapest for all the purposes, and we imagine the most valuable result of the building of this ship will not necessarily be that she will be followed by similar sisters. Her value lies in the fact that she once for all demonstrates that properly-carried-out electric welding is "all right" for shipbuilding. This should lead to the very extensive use of welding in the very large number of shipbuilding jobs for which it is eminently suitable, convenient and economical.

A midship section of the boat is given in Fig. 1 above, while details of a number of the joints incorporated in the construction are given in Figs. 2 to 14, on the next page. The hull is constructed of steel of the usual ship qualities tested in accordance with Lloyd's rules in the ordinary way. It is interesting to note that the majority of the steel was ordered neat, or at least with less working allowance than usual. The general features of the method of construction adopted will be followed from Fig. 1, but the detail of the various types of joints will best be discussed in connection with Figs. 2 to 14. As a working rule it was arranged that as far as possible no overhead welding should be called for on the job. The complete elimination of overhead welding on assembly was, of course, impossible, but in almost every case it was found that joints could be planned so that such overhead welding done on the ship was required to be only of a light type as it was reinforced by a heavy weld put on in a downward direction. The planning of the construction from this point of view and also with the idea of carrying out as much welding as possible in the shops naturally required much careful design and consideration of details.

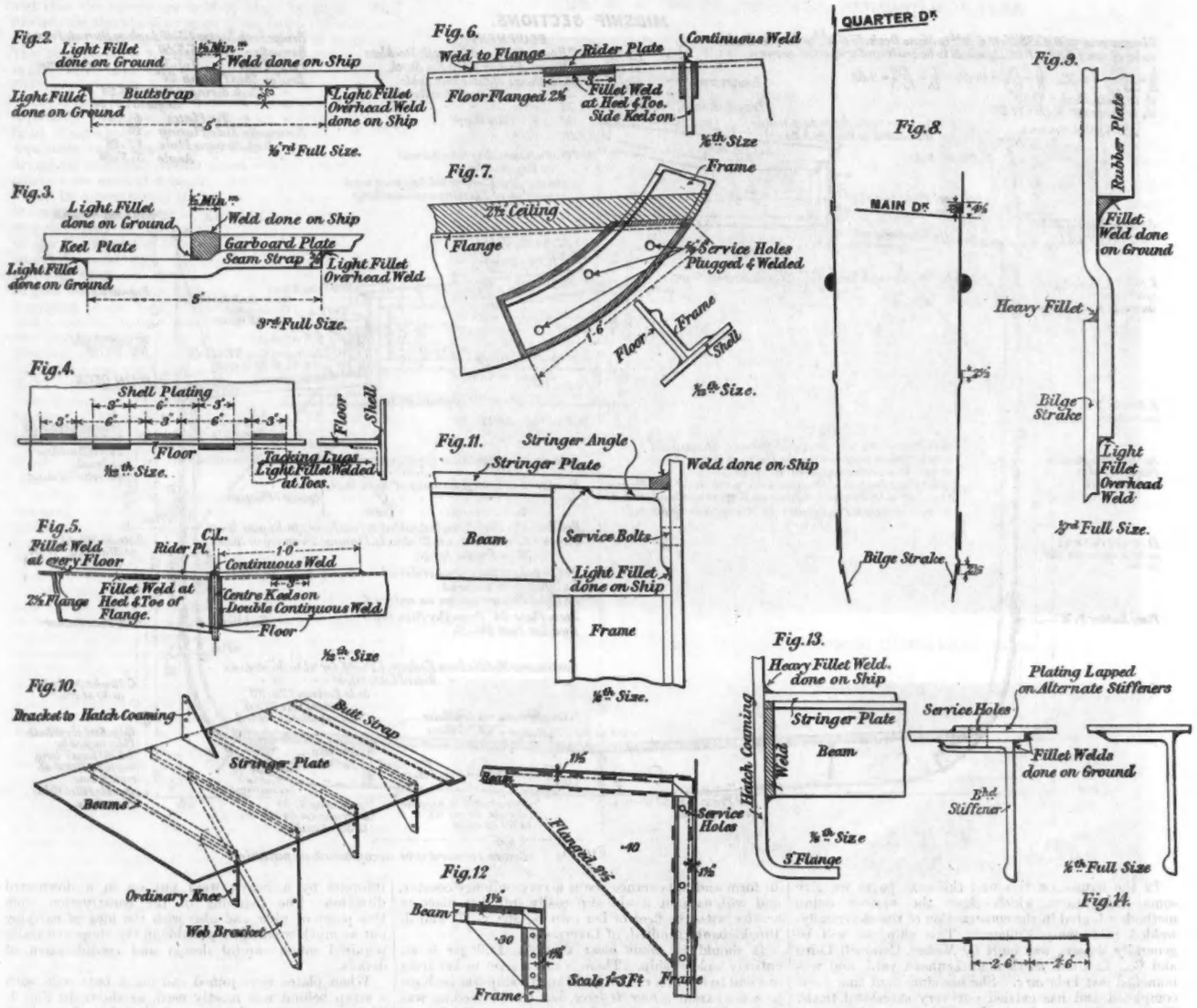
When plates were joined end on, a butt weld with a strap behind was mostly used, as shown in Fig. 2. The strap is secured to one of the plates by a light fillet which can be put on from above when the plate is in the shops, or yard. After assembly, the main weld can then be carried out working downwards and the only overhead work is the second light fillet as shown in the figure. A similar construction is used for the joint between the keel plate and the garboard plate, as shown in Fig. 3; the strap being set to correspond with the difference in thickness between the plates. The position of this joint can be seen in Fig. 1. When plates are lapped, as in the shell plating, a continuous weld is put on on both sides. Again, however, the main heavy weld is the one that can be worked downwards, and the overhead weld is of a lighter type. This is illustrated in Figs. 8 and 9, which show details of the shell plating and also the method of attaching the rubber plate.

In very many cases throughout the work a system of broken welding is used. By this we mean that in joints not required to be watertight the welding is put on in short lengths with unwelded spaces between instead of being continuous. The only idea in this is, of course, economy of labour and material and the actual jointing material between the plates which are connected is probably of considerably greater section than would be given by riveted joints. This discontinuous welding is clearly shown at the connections between the main frames and the shell plates in Fig. 1. As will be seen, the welds are placed alternately on either side of the frames. The arrangement is shown to a larger scale in Figs. 4 to 6. A detail showing the construction used at the lower end of the main frames

* See ENGINEERING, vol. cix., page 144.

THE ELECTRICALLY-WELDED SHIP "FULLAGAR."

CONSTRUCTED BY MESSRS. CAMMELL LAIRD AND CO., LIMITED, BIRKENHEAD.



is given in Fig. 7. As will be seen, the frame is welded all round to the plate. Service holes are shown in this figure. These are, of course, employed in connection with erection, but in order to conserve the all-welded construction they are not riveted after use, but are plugged and welded over.

The construction adopted at the top of the main frames is shown in Fig. 11. This figure is self-explanatory, and again the service bolthole is shown. The deck beam is attached to the stringer plate by discontinuous welding in the manner we have already described, and as shown in Fig. 1. This work was in the main carried out in a downward direction before assembly. In certain cases in connection with deck construction in which it was not possible to carry out downward welding to the full extent that was desired, a series of countersunk holes were drilled in the plates. After assembly these were filled in by welding from above, so that a metallic connection was established between the plate and the beam below. Our remaining figures require little comment. Figs. 10 and 12 give details of the web bracket and knee connections to the stringer plates, while Fig. 13 is a detail of the hatch coaming construction. The three detail views constituting Fig. 14 show the bulkhead construction and the method of attaching the stiffeners.

The whole of the welding carried out in connection with the construction of the Fullagar has been carried out by the quasi-arc system and in the presence of a representative of the Quasi-Arc Company, Limited, of 3, Laurence Pountney Hill, Cannon-street, E.C. 4. The adoption of this process followed the successful repair of the stern frame of a battleship which had developed a serious fracture. The quasi-arc system was employed in this case and after very severe tests at sea the result was so satisfactory that Messrs. Cammell Laird decided to experiment further with this system of welding. Concerted action was taken by the company and Lloyd's Register of Shipping, and a series of tests were arranged to decide as far as possible on a small scale whether welded joints could be relied upon to replace riveting in a ship. In the first case the technical side of the problem was dealt with, and, in addition to obtaining information on tensile strength, the elastic properties of welded metal and its resistance to continuous reversal of stresses were investigated. Chemical and microscopic tests were also made. As a result, Lloyds Register of Shipping gave their approval to the quasi-arc electric welding process for ship construction and a set of rules for its application is now embodied in the ordinary rules of the Society. Messrs. Cammell Laird are to be congratulated on putting these rules to so very complete a test as is involved in the construction of the Fullagar. She will probably have much influence in connection with the future adoption of electric welding in many, even if not in all, features of ship construction.

PORT OF MARANHAO.—The Maranhao correspondent of the British Chamber of Commerce, Rio de Janeiro, writes: "At the Palace of the President of the State, on April 6, a contract for the improvement of the Port of Maranhao was signed by the representative of the Government and by Dr. Henrique Lange, as representative of Messrs. C. H. Walker and Co., of London. The estimated cost of the work is 15,000 contos of reis—or 1,000,000*l.* (at 16*d.* exchange)."

BILGE PUMPING IN PASSENGER STEAMERS.—The Marine Department of the Board of Trade have published their circular, No. 1,615, which gives instructions based on the recommendations of the Bulkheads Committee. The instructions are issued under the provisions of the Merchant Shipping Acts for the assistance and guidance of the Board of Trade officers in surveying passenger steamers. They deal with bilge-pumping arrangements, and are to be substituted for paragraphs 80 to 83 of the "Instructions as to the Survey of Passenger Steamships," issued in 1913, and are to be considered as forming part of those instructions.

BRAZILIAN WATER POWER.—Dr. Alvaro Rodovalho, engineer, of the Railway Inspection Department, has given an important statement respecting hydraulic power available in Brazil. He states, says the British Chamber of Commerce, Rio de Janeiro, that up to the present, 184 waterfalls have been recorded—not including any of less than 6,000 h.p. The total power of these falls he estimates at 30,000,000 h.p., of which hitherto only an insignificant proportion has been utilised. The work of studying and registering these falls is being carried out by the Ministry of Communications and Public Works, and is a valuable step towards the industrial development of the country. Among other works in contemplation are the electrification of part of the Central Railway system in Rio and the Paulista Railway in the State of S. Paulo.

THE GERMAN LONG-RANGE GUN.*

By Lieutenant-Colonel H. W. MILLER,† U.S.A.

AT 7.15 on the morning of March 23, 1918, just two days after the Germans opened their offensive against the British 5th Army before Amiens, the people of Paris were startled by an explosion of something that had fallen on the Quai de Seine. The explosion was of such magnitude that it could be heard over practically the whole of Paris. Fifteen minutes later there was another explosion of the same magnitude, but this time closer to the Seine, on the Rue Charles V; 15 minutes later another explosion occurred on the Boulevard de Strasbourg near the Gare de l'Est. Until that time Paris had never been bombarded except from airplanes and zeppelins, and the first thought of the people was that they were being bombarded from some new type of aircraft that was being operated at such a height that it was practically invisible.

The explosions continued to occur throughout the morning at very uniform intervals of 15 minutes, and by evening 21 explosions had occurred at the places shown in Fig. 1. After the first few explosions, between seven and eight o'clock in the morning, business in Paris practically ceased. Stores were closed; part of the underground railway ceased to operate; ticket offices in some of the railway stations were closed, and great numbers of people could be seen walking the streets looking skyward trying to locate the planes that were dropping the supposed bombs.

THE BOMBARDMENT OF PARIS.

Information of the extraordinary bombardment was telephoned and telegraphed over practically the whole of France within a few hours and was received everywhere with amazement. After a few hours of the first day a sufficient number of the fragments of the exploding agent were collected by officials in Paris to identify it as a projectile being fired from a gun, rather than a bomb being dropped from an airplane. By noon representatives of the Heavy Artillery Section of the Ordnance Department, located at Tours, had made preliminary calculations in response to telephone instructions from Paris giving the probable muzzle velocity at which a projectile would have to start in order that it might travel from a few kilometres within a point of the German lines nearest Paris to the centre of Paris. Inquiries were made likewise of the section as to the possibility that these projectiles could actually be coming from a gun within the German lines. The reply was that the probable muzzle velocity of the projectile, if it was actually being fired within the German lines, was not less than 4,500 ft. per second. No such muzzle velocity had, to their knowledge, ever been realised, but with a gun of sufficient length and with a powder burning at a satisfactorily low speed it was considered quite possible for the projectiles to be fired from within the German lines. By the end of the first day officers of the French, as well as the American, armies were quite certain that the projectiles were being fired from a newly-designed long-range gun located within the German lines, and operating at a probable range of 110 km. (68·8 miles).

During the next few days some interesting theories were advanced in the various newspapers. In one case it was maintained that the projectiles which arrived in Paris were being fired from another much larger projectile, which actually served as a gun. This larger projectile was said to have been fired from a gun within the German lines, and upon attaining a certain height a charge of powder within the larger projectile was automatically ignited, firing the smaller one to a much greater distance. The theory that the projectiles were being fired from guns concealed in abandoned quarries or in heavily wooded regions near Paris received considerable credence, and diligent search was made of all such places to be certain that it was not true. A third theory was that the projectiles were being fired from a pneumatic gun located within Paris.

A plotting of all the bursts for the first day showed results that were very puzzling. If the guns were being operated at comparatively short distances, the only way to account for the tremendous dispersion was on a basis of actual laying of the gun for different objectives. This theory did not seem plausible, however, because if the gun was actually laid on given objectives, these objectives were of relatively small importance. If, on the other hand, the projectiles were being fired from a gun at a great distance, it was seen at once that the dispersion was so great as to make it practically impossible to hit with any certainty any objective much smaller than that portion of Paris within the walls. It was noticed that the dispersion in direction, that is, to the right or to the left of the line on which the projectiles were arriving, was comparatively small, while the dispersion in range, that is, over or under the probable point at which the projectiles were supposed to arrive, was very great. Examination of the map, Fig. 1, shows that on this first day, when the gun was new, the average dispersion in range was very small compared with the dispersion on later days when the gun became worn.

Evidence received later indicates that at the end of this first day's bombardment the first gun was about half worn out. Eighteen projectiles had fallen within the walls of Paris, and three outside; 15 people had been killed and 36 wounded. The destruction of property had been comparatively small. By "comparatively" it is meant that the destruction was small in comparison with that wrought by the 100-kg. and 300-kg. airplane bombs. Whenever the projectiles landed in the street or in an open plot of ground, the hole made was seldom more than from 12 ft. to 15 ft. in diameter, and from 4 ft. to 6 ft. in depth. When the projectiles struck buildings it was not unusual to have them explode in the interior without showing any serious signs of damage on the outside.

On March 24, 13 projectiles fell within the walls of Paris and 9 without, killing 11 people and wounding 34. On the 25th, 4 projectiles fell within the city and 2 without. This was the end of the first gun. It was worn out, and no more firing was done until the 29th, when the second gun began its work.

Search of the files of the French War Office revealed the fact that full drawings and plans had been on hand for quite a long time for such a gun as the Germans were probably using. These specifications had been submitted a number of years before and had been discarded because of the excessive expense and the tremendous difficulties involved in manufacturing such a gun. It was considered likewise by those who had turned down the specifications that the value of such a gun was extremely questionable. It was realised that its dispersion would be excessive, and that with the powders with which the service was then familiar it would be exceedingly difficult to secure a muzzle velocity sufficiently uniform to do effective work.

DETAILS OF THE BOMBARDMENT.

When the bombardment was over an examination of the periods over which it had extended indicated that it had been divided into three distinct series. The first extended from March 23 to May 1; the second from May 27 to June 11, and the third from July 15 to August 9. It seems certain that this division into series was a part of the plan of the large offensives being waged during that time. Table I on page 30 gives the bombardment by days during this entire period and shows the number of projectiles falling within and without the walls of Paris each day, and the number of people killed and wounded. During the first few days of the bombardment the first projectiles arrived between seven and eight o'clock in the morning and continued to fall at intervals of 15 minutes through a portion of the day. On later days the bombardment would begin at 12.40 p.m.

Much has been said with reference to the effect of this bombardment on the people of the city of Paris. The writer's first direct acquaintance with the bombardment was during the third and fifth days. With considerable surprise it was observed that already the people were taking it quite philosophically; in fact, it could not be seen that they were paying much attention to it at all. At intervals of about 15 minutes muffled explosions would be heard in different parts of the city, seldom two consecutive explosions in the same vicinity. Many people would stop for an instant and attempt to decide from what direction the sound had come, after which they would go on their way apparently unconcerned. It was, of course, still sufficiently novel to be of considerable interest, and people were talking about it everywhere. It is quite probable that the regularity with which the projectiles were arriving got on the nerves of some people, and that the bombardment was responsible for the departure of some of those who were crowding the trains west and south from Paris. It seems more certain, however, that by June 1 the close proximity of the Germans to the city of Paris, together with the anxiety caused by another drive impending, added to the effect of the heavy bombardments from airplanes on every clear night, had far more effect than the gun. The visible destruction of property was so slight as to give little evidence to any one travelling about the city that the explosions they were hearing from time to time amounted to anything. The newspapers were very careful to avoid any discussion or even a lengthy reference to the bombardment from day to day, and neither gave the locations of the places where the projectiles had fallen nor the number of killed or wounded.

The Germans must certainly have known that their gun was not a profitable investment for the destruction of property, hence they must have continued the bombardment purely for its destructive effect on the morale of the Parisians and its beneficial effect on the morale of the Germans. This is likely the purpose which prompted the construction of the guns. In his book, "My Thoughts and Actions," General Ludendorff says: "During the battle we had commenced bombarding Paris from near Laon with a gun having a range of 75 miles. This gun was a marvellous product of technical skill and science; a masterpiece of the firm of Krupp and its director, Rausenberger. The bombardment made a great impression on Paris, and on all France. Part of the population left the capital and so increased the alarm caused by our successes." He is right, the bombardment did make a great impression; it made every one more angry, and alarmed very few. It is certain now that they could ill afford to use their manufacturing facilities for the making of such guns as these at a time when they were so desperately in need of heavy field guns to assist their armies in their big drives.

Long-range or super guns received consideration from the allies for a very short period. There was a tendency at the time to favour construction of a great number of them, but a saner view soon prevailed and actual steps were taken for the construction of only a very few. Both the British and the French Governments began the construction of a limited number, some of which have now been finished. They built them, however, with a clear understanding that they could hope for but little more from them than the Germans were getting from their own. American ordnance officers feel that it would not profit us to construct more than two or three such guns at the very most, and probably none at all.

Within a very few days from the beginning of the bombardment it was possible, through careful examination of the direction of the passage of the projectiles through various buildings, to determine quite accurately the direction of their arrival and the probable place from which they were coming. This place was in the Forest of Gobain, south-west of Laon. Very soon thereafter the French Air Service was able to locate in this same forest three positions from any one of which, or possibly from all of which, the guns were being operated. Only one of these was sufficiently close to the German and the allied lines to permit of any possibility of operating against it with the heavy guns then in service. The gun selected was a 34-cm., 45-calibre French gun on a railway mount. This mount was run up to a point very close to the lines and behind a hill of such size as to effectively conceal it from the German line observers. It was well camouflaged by nets against the air observer and against German sound-ranging apparatus by placing two smaller guns at the right and left and several hundred yards behind it. These smaller guns were fired at intervals of 1 second and 2 seconds before the larger gun, and evidently had the effect of so disturbing the German sound-ranging apparatus as to make it impossible to locate the heavy gun. After a half-day's firing from the 34-cm. gun, air photographs indicated that the emplacement had been destroyed. The airmen undertook to demolish the other two emplacements, and their photographs indicated that they had inflicted considerable damage. Apparently they did not secure any direct hits, for the gun or guns continued to fire without any long intervals between shots.

After the advance of the allies it was impossible to determine from examination of the emplacement which had been nearest the allied lines whether a gun had actually been on this position or not. A German artillery officer who worked with the Americans for some time in the forward area after the armistice, and who spoke with such certain knowledge of the long-range gun, as to indicate that he knew the details of design and had seen it, insisted that the position that had been destroyed by the allies had not had any gun on it.

Mention has already been made of the destruction of property by these long-range projectiles. Except in a few places where the damage was so exposed as to attract attention, no matter how slight it might be, there was little evidence that the bombardment had any effect. On March 29, the day on which the second gun began to fire, and fired only four projectiles, the one projectile which landed within the city of Paris struck and knocked out the keystone in one of the arches in the roof of the church of St. Gervais, near the Hotel de Ville. The falling of the keystone caused a large part of the arch and the roof to collapse, and most unfortunately the church was quite full of people at the time. Examination of Table I will show that this day holds the record for casualties. On one other occasion a projectile burst in the lobby of a hotel, killing a number of people but doing comparatively little in the way of material damage. Ordinarily an explosion would make only a comparatively small hole in the ground.

Even during the active periods of the three series noted above there were many days on which the gun did not fire. It is quite certain that between March 25 and 29 the first gun was being removed and a new one placed on the carriage. By the end of March 25, 49 projectiles had arrived, and the probable life of the guns is not more than 50 rounds. It is likely that the guns were changed again between April 7 and 11 and between April 21 and 24.

After the armistice it was learned that the Germans had constructed a total of seven guns. These guns were first constructed to a diameter of 21 cm., and after being worn out as 21-cm. guns were rebored to 24 cm. All of the projectiles of the first two series were 21 cm. in diameter, but during the last days of the third series the projectiles were 24 cm. in diameter, indicating that the entire seven guns had been worn out, and that probably the gun that had commenced firing on Paris on March 23 as a 21-cm. gun had been rebored and fired again as a 24-cm. gun. It was learned also that the Germans were reboring the remainder of the seven guns and were constructing additional guns at Essen. Representatives of the Ordnance Department found in the Skoda Works at Pilsen three more guns, while the engineer at these works said were under construction long-range gun at the time of the armistice. In July, 1918, the Intelligence Service transmitted information to the effect that one gun had been destroyed by a premature explosion. No confirmation of this report has ever been found, and it cannot be considered a certainty.

The third series began on July 15, with 10 projectiles, followed by four projectiles on the 16th. The bombardment then ceased for three weeks, beginning again on August 5 and continuing daily until the 9th. On this day 12 projectiles arrived, only two of which fell within the walls of Paris. The famous bombardment was finished. A comparison of the distribution of the bursts on this last day (Fig. 2) with the locations on the first day (Fig. 1) is very interesting. On the first day a considerable number of the projectiles fell within a very small area in the north-east of Paris. On this last day it will be observed that they are scattered over the western section of Paris, and no two are very close together. The last projectiles of the entire bombardment fell between one and two o'clock on August 9. Already the Allies in their successful drive north of the Marne and between Soissons and Rheims were driving the Germans back so rapidly and had made such progress as to put the long-range guns in serious danger.

Fig. 3 shows the location of all of the bursts within the walls of the city, a total of 183; 120 more fell outside of the city, making a total of 303 fired from seven 21-cm. guns, and probably one gun rebored to 24 cm. The

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* Released for publication by the War Department. Office of the Chief of Ordnance, and contributed to *Mechanical Engineering*, the Journal of the American Society of Mechanical Engineers, from which we reproduce it.

† Office of Chief of Ordnance, Artillery Division, Washington, D.C.

bombardment continuing actively over 44 days. Even before the last day of the bombardment American forces operating north of the Marne had captured an emplacement 9 km. (5 miles) north of Chateau-Thierry. This emplacement will be described in detail later. It was 86 km. (53·4 miles) from Paris, and it is understood that to the carriage. The various reports on the gun agreed quite closely in the essential details.

In May, 1919, a commission of ordnance officers was sent to the Skoda Works in Austria for the purpose of investigating their methods of constructing large and small ordnance. While there they secured additional construction of a greater number of guns than they were able to handle at the Krupp Works at Essen.

The details of the design of the carriage for the gun were not learned until April, 1919, although it had been quite certain since August, 1918, that the emplacement found south-west of Fere-en-Tardenois was intended

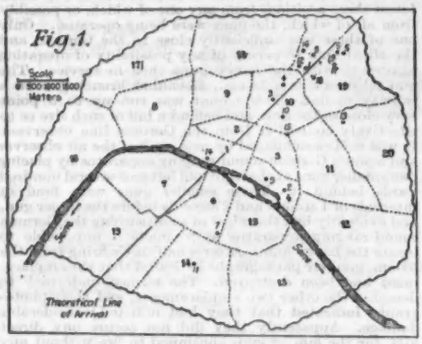


FIG. 1. MAP OF THE CITY OF PARIS, SHOWING POINTS OF BURSTS ON FIRST DAY OF LONG-RANGE BOMBARDMENT (MARCH 23, 1918) IN THE ORDER OF THEIR ARRIVAL.

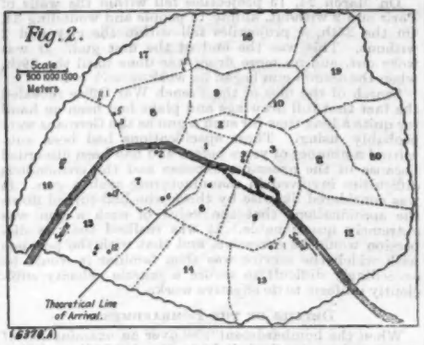


FIG. 2. MAP OF THE CITY OF PARIS, SHOWING POINTS OF BURSTS ON LAST DAY OF THE LONG-RANGE BOMBARDMENT (AUGUST 5, 1918), IN THE ORDER OF THEIR ARRIVAL.

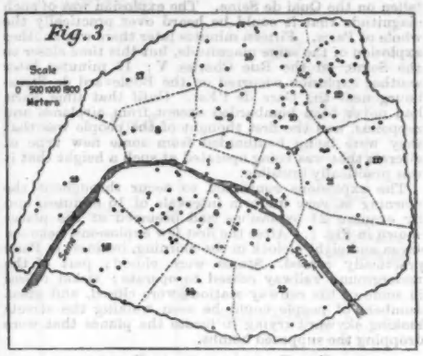


FIG. 3. MAP OF THE CITY OF PARIS, SHOWING POINTS OF BURSTS OF THE 183 PROJECTILES THAT FELL WITHIN THE WALLS IN 44 DAYS OF BOMBARDMENT.

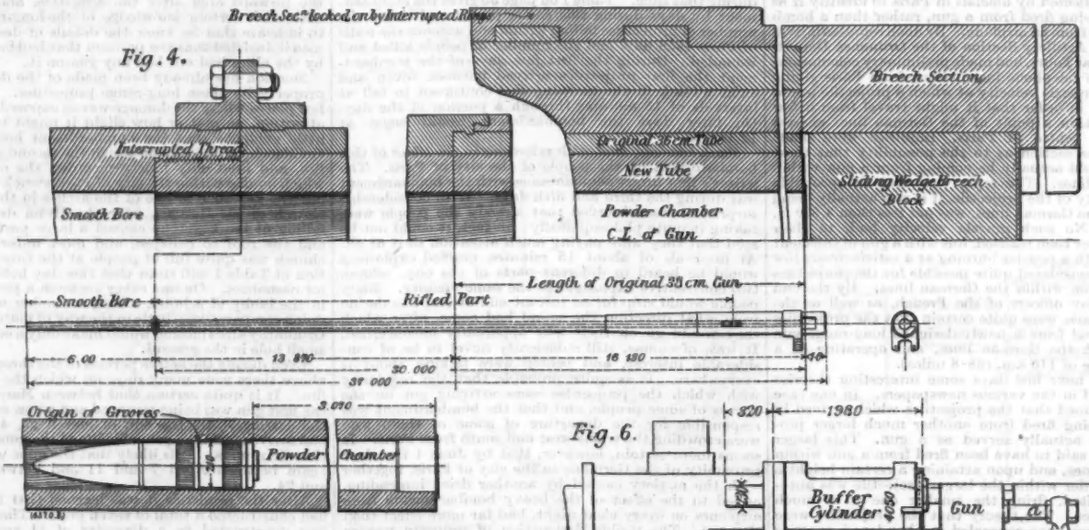


FIG. 4. DETAILS OF THE GUN (DIMENSIONS IN METRES).

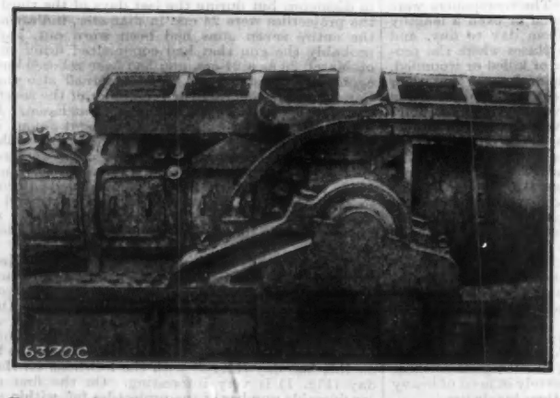


FIG. 5. CRADLE, COUNTERWEIGHTS AND ELEVATION ARC OF GUN.

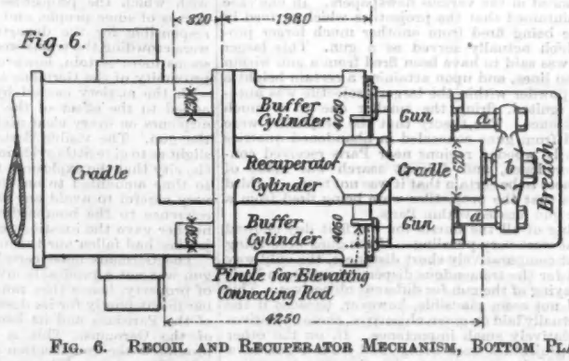


FIG. 6. RECOIL AND RECUPERATOR MECHANISM, BOTTOM PLAN.

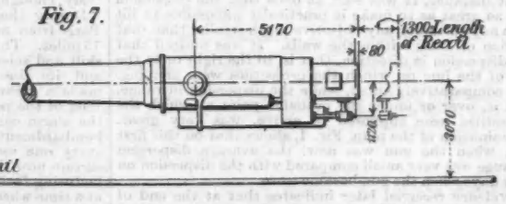


FIG. 7. CRADLE RECOIL MECHANISM.

it was a new emplacement from which the Germans had hoped to operate the super guns more effectively.

DESIGN OF THE GUN, CARRIAGE AND EMPLACEMENT.

It has been mentioned before that the Germans used seven guns of a calibre of 21 cm. or 8·15 in., that they had rebored at least one of them to 24 cm., or 9·3 in., and that at the time of the armistice three more guns were under construction at the Skoda Ordnance Works at Pilsen in Austria. During the period of active warfare many reports were received with reference to the design of the gun, but never any information with reference data from the chief engineer of the plant with reference to the design of the gun, and saw the three guns which had been in process of construction on November 11, 1918. This engineer stated that when the first German gun began to fire on Paris, it was as much a surprise to the Austrians as it was to the Allies. Shortly thereafter he went to France to examine the gun and observed it in action. It was not until a few months before the armistice that the three guns were sent to Pilsen for conversion into long-range guns. Evidently the Germans had considered the bombardment a success, or sufficiently so to warrant the use of manufacturing facilities for the for the carriage of the long-range gun. Until July 1, 1919, no direct information had been received from the Germans with reference to the design of any part of the entire mechanism except the gun on which, as mentioned before, information had been received at various times before the armistice; the guns themselves were examined at the Skoda Works at Pilsen. Just why the Germans refused to talk about this gun is not known. In December, 1918, and January and February, 1919, a German engineer who was working with the American forces in the region north-east of Verdun helping to identify long-delay fuses and assisting on other technical

matters, said that he was acquainted with the design of the gun and had seen it in operation. Very curiously, however, he refused to give any information with reference to the details of the design and was quite positive in his assertions that the Allies would never see any of the guns, and certainly not any of the carriages. This was difficult to understand in view of his perfect willingness to talk about the details of design of any other piece of ordnance that he was at any time asked about, and it was more curious in view of the fact that there is really nothing wonderful about the design of the long-range gun, its carriage or its emplacement.

THE GUN.

All the long-range guns were constructed from worn-out

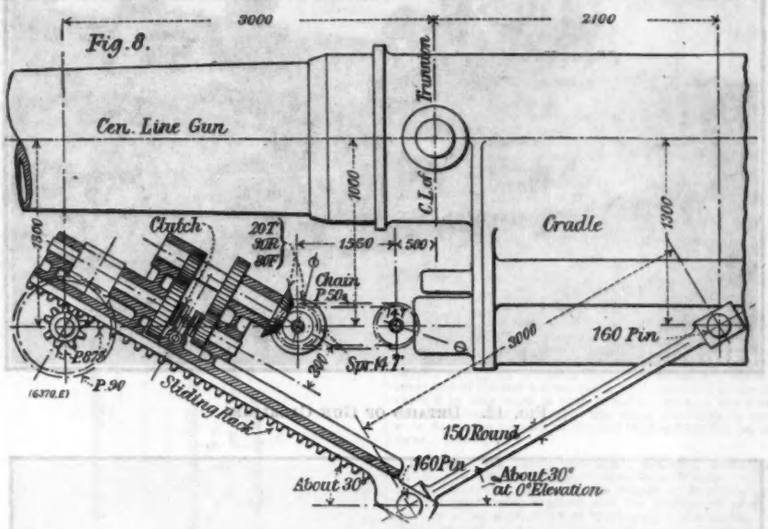


FIG. 8. SIDE ELEVATION OF ELEVATING MECHANISM.

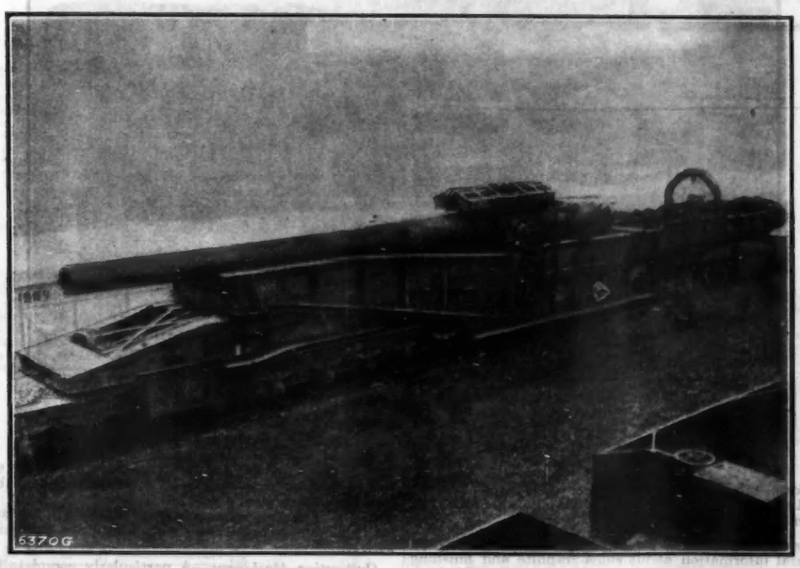


FIG. 10. THE GUN CARRIAGE WITH 38-CM. 45 CALIBRE GUN FROM WHICH THE LONG RANGE GUNS WERE MADE.

38-cm. (15 in.) 45-calibre (17·1 m. or 56 ft. in length) naval guns. The converted gun was in two parts, the main section 30 m. or 98·5 ft. in length, and the forward section 6 m. or 19·7 ft. in length. The 38-cm. gun was bored out and a very heavy tube with an inside diameter of 21 cm., was inserted, Fig. 4; 12·9 m. or 40·23 ft. projected beyond the end of the original gun, and over this projecting portion another hoop was shrunk and locked to the forward hoop of the old gun. This 21-cm. tube was rifled at a uniform twist throughout its length. The other section, 6 m. in length, was attached by means of an interrupted thread and heavy outside collars or flanges. This section was unrifled and was of an inside diameter equal to 21 cm. plus twice the depth of the grooves in the rifled section. It was assembled to the gun in the field and not removed until the gun had been worn out. The total weight of the original 38-cm. gun was 152,550 lb., and the weight of the reconstructed gun approximately 318,000 lb. The 21-cm. liner was of such thickness that on being worn out at this calibre it could be rebored first to 24 cm. (9·3 in.) and later to 26 cm. (9·93 in.). Its probable life at any one calibre was not more than 50 rounds, and the maximum powder pressure did not exceed 3,000 atmospheres or 44,000 lb. per square inch. The design of the breech mechanism of the original 38-cm. gun did not require modification.

The long-range guns constructed by the British and French governments do not follow the German design to the extent of having a smooth-bore section on the front. The purpose of this feature was for some time in doubt and is worthy of some discussion.

The gun just described is approximately 3 m. longer than either the British or French long-range guns, both of which are rifled throughout their length. Two reasons might be given for the extra section.

Possibly additional linear velocity was imparted to the projectile as it travelled through the 6-m. smooth-bore section. It seems improbable, however, that this could be its primary purpose, inasmuch as the muzzle velocity was such a variable quantity. It is more probable that its purpose was to align the axis of the projectile more perfectly with the axis of the bore of the gun and reduce to a minimum the angular velocity of yaw as the projectile left the muzzle. When it is understood that this projectile was to mount to a height of about 24 miles and travel a horizontal distance of 76 miles, it can easily be appreciated that any tendency that the projectile might have to throw its axis out of alignment with its theoretical path would have disastrous results. Through the impracticability of making projectiles fit perfectly in a gun they have a tendency to hammer the walls as they travel down the bore. This hammering action of the projectile is the result of the operation of two forces, the one tending to increase its linear velocity and the other to increase its rotational velocity. The latter force is acting only while it is travelling through the rifled section. It is invariably true that just as the projectile is leaving the ordinary gun it is on one of its up, down or crosswise hammer strokes, and that the axis has a tendency to yaw or deviate from its theoretical path at a certain angular velocity. Cardboard screens placed in front of guns in proof firing invariably show elongated holes, and not infrequently very decidedly so, even at no greater distances than 100 ft. from the muzzle. This tendency to yaw has a detrimental effect on the accuracy of even our comparatively short-range guns, but no

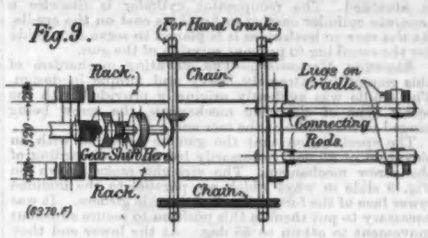


FIG. 9. PLAN OF ELEVATING MECHANISM.

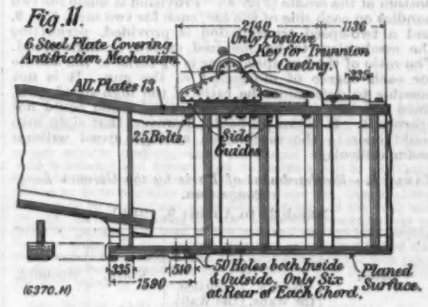


FIG. 11. GIRDER DETAILS.

effective means have yet been devised to neutralise it. With the extreme-range gun it is so much more serious that it seems quite likely that the Germans adopted this method of neutralising it, thereby reducing the dispersion both in range and in direction. It is not improbable that the German gun was first constructed without the smooth-bore section, and that its shooting was found to be so erratic as to require the addition of this feature.

This gun was operated at a muzzle velocity of from 1,500 m. (4,760 ft.) to 1,600 m. (5,090 ft.) per second and at an elevation of 55 deg. This 55 deg. is worthy of comment, inasmuch as it has ordinarily been supposed that nothing could be gained in range by elevating a gun above 45 deg. It is known, of course, that if a projectile is fired in a vacuum its maximum range is attained when it starts at an elevation of 45 deg. When fired in the air, however, the initial angle which permits it to attain its maximum range depends both on the calibre and weight of the projectile and the velocity at which it leaves the gun. With reasonably large and well-designed projectiles, it may be said that for each muzzle velocity (*a*) there is a density of air (*b*) into which the projectile should enter at an approximate elevation of 45 deg. For this projectile and the muzzle velocity of 1,500 m. per second the initial elevation of the projectile is 55 deg. It is very doubtful whether any additional range can be secured with any projectile at any muzzle velocity at an elevation above 55 deg.

Attention was called in the discussion of the first day's bombardment to the tremendous disperson in range. Some of the projectiles fell just within the wall at the north-east side of Paris, and some within the walls at the south-west side. This is accounted for by the fact just mentioned that the muzzle velocity of the projectile varied as much as 100 m. per second. It was impossible with the powder that the Germans were using to secure a muzzle velocity with a variation of less than 100 m. per second.

THE GUN CARRIAGE.

Cradle.—The cradle, Fig. 5, is a cylinder of simple design having ribs at long intervals and of a depth of only about 3 cm. The walls of the cylinder have a minimum thickness of 10 cm. and a maximum thickness of 13 cm. over the ribs. The diameter of the main trunnion is 46 cm. and the length 33·5 cm. A collapsible counterweight is attached to the top of the cradle. In firing, the two sections of this counterweight are raised and locked together for the purpose of raising the centre of gravity to such an extent that the gun may be elevated and depressed more easily. This cradle is of a naval design, the front section being so shaped as to close the opening in a turret. It is not improbable that the cradle as well as most of the 38-cm. guns were removed from German ships or coast fortifications.

Recoil Mechanism.—The recoil mechanism is composed of two hydraulic recoil cylinders and one spring-pneumatic recuperator cylinder, all attached to the bottom of the

cradle, Figs. 6 and 7. Each of the recoil cylinders is a separate cylinder carried in brackets cast on the cradle, and each is provided with a buffer approximately 32 cm. long. The plugs through which the cylinders are filled are on the ends of the buffers. The approximate length of recoil is 1·3 m. (50·5 in.). This distance is, of course, approximate, and was arrived at after careful examination of the cradle. A report examined in the office of the Chief of Artillery of the Belgian Army at Brussels gives the length of recoil as 1·15 m. Inquiry disclosed the fact that this length of recoil was also approximate.

Two rods *a*, *a*, screwed to the recoil lug of the gun, Fig. 6, and extending to the rear, carry a heavy cross-head *b* to which the piston of the recuperator cylinder is attached. The recuperator cylinder is likewise a separate cylinder carried in brackets cast on the cradle. At the rear on both sides it is planed to serve as a guide for the recoil lug to prevent rotation of the gun.

Elevating Mechanism.—The elevating mechanism of this mount is extremely heavy and unique in design. The cradle was evidently originally provided with the screw type of elevating mechanism, the screw being hinged to the cradle at the rear end.

The specification that the gun be provided with an elevation of 55 deg. necessarily led to the discarding of the screw mechanism. The straight racks shown on Fig. 8 slide in ways which are parallel to the inclined lower face of the forward end of the side girders. It was necessary to put them in this position to secure sufficient movement to attain to 55 deg. At the lower end they are connected with each other by a heavy shaft to which are attached the two connecting rods running up to the bottom of the cradle (Fig. 9). Provision is made for two handles on each side of the car, each for two men, Fig. 9, and a two-speed transmission is provided, permitting the mechanism to be operated at low or high speed. The ratio of the low-speed gear is 4½ turns of the handle for each degree of movement of the gun. It is not possible to determine the ratio of the high-speed gear, since the two men making the examination could not operate it. It seems probable, however, that eight men could operate the mechanism at high speed without undue difficulty.

TABLE I.—*Bombardment of Paris by the German Long-Range Gun.*

(March 23 to August 9, 1918.)

Dates.	No. of Projectiles.		Killed.	Wounded.
	Within the Walls.	Outside the Walls.		
March 23 ..	18	3	15	36
,, 24 ..	13	9	11	34
,, 25 ..	4	2	1	3
,, 29 ..	1*	3	88*	63
,, 30 ..	16	3	10	60
,, 31 ..	3	—	1	1
April 1 ..	3	1	8	8
,, 2 ..	3	1	—	3
,, 3 ..	1	—	—	—
,, 6 ..	2	4	—	3
,, 7 ..	—	1	—	—
,, 11 ..	5	1	9	21
,, 12 ..	5	2	2	14
,, 13† ..	6	2	—	—
,, 14 ..	3	1	—	—
,, 15‡ ..	3	2	—	—
,, 16 ..	2	1	17	114
,, 19 ..	1	2	—	—
,, 21 ..	2	—	—	—
,, 24 ..	—	1	—	—
,, 25 ..	6	4	1	—
,, 26‡ ..	1	—	—	—
,, 30 ..	—	3	—	—
May 1 ..	—	1	—	5
,, 27‡ ..	7	7	4	20
,, 28 ..	6	4	1	2
,, 29 ..	5	5	1	7
,, 30 ..	4	5	13	5
,, 31 ..	1	3	—	—
June 1 ..	—	4	—	—
,, 3 ..	—	6	2	3
,, 4 ..	4	—	4	16
,, 7 ..	3	1	1	4
,, 8 ..	1	2	3	—
,, 9 ..	1	3	1	9
,, 10 ..	2	2	3	13
,, 11 ..	—	1	—	—
July 15 ..	9	1	6	9
,, 16 ..	4	—	3	8
August 5 ..	13	4	32	61
,, 6 ..	12	7	8	39
,, 7 ..	8	4	7	43
,, 8 ..	1	4	1	—
,, 9 ..	2	10	3	6
Totals ..	183	120	256	620

* Shell struck an arch in the roof of the Church of Saint Gervais.
† Night and day. ‡ Night.

Traversing Mechanism.—See later paragraphs dealing with the anchorage.

Railway Car Body.—The railway car body shown in Figs. 10, 11, 12 and 13 is made up of two single-web side girders connected at the front and rear by heavy structural steel transoms. They are further reinforced in the front by the heavy cast-steel housing for the elevating gear. The trunnion seats are of cast steel and are simply bolted to the top chord with single key plates at their rear. This single key plate has the positive backing of one top cover plate. The face of the horizontal section of the lower chord of the side girders is planed and is provided with key plates at each end, Fig. 11. Eight 2-in. holes are provided in each lower chord at the front end and six at the rear for bolting the mount to the emplacement.

(To be continued.)

THE GERMAN LONG-RANGE GUN.

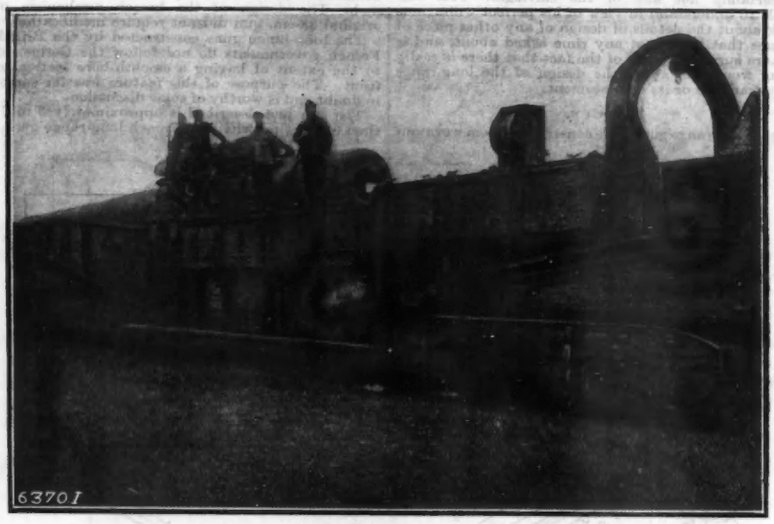


FIG. 12. DETAILS OF GUN CARRIAGE.

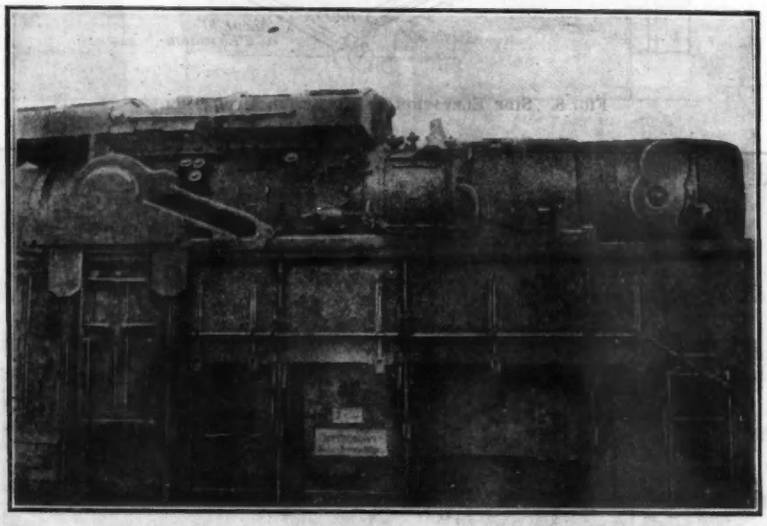


FIG. 13. SIGHT, RECUPERATOR PUMP AND BREECH MECHANISM.

CATALOGUES.

Fans.—Messrs. Davidson and Co., Limited, Belfast, send a small booklet relating to their fans which are used for marine, mine and general service.

Graphite Paint.—A book of specimen colours and general information about silica-graphite and finishing paints has been issued by Graphite Products, Limited, 220, Queen's-road, Battersea, London, S.W. 8.

Machine Tools.—Lathes, planing machines, milling machines and radial drilling machines are the subjects of special catalogues received from Messrs. Joseph T. Ryerson and Son, New York, U.S.A. These are all heavy, high-power machines of considerable capacity, and they represent much larger types than it has hitherto been customary to import from the United States.

Small Oil Engines.—Two-stroke vertical oil engines of 2½ h.p., 5 h.p., 9 h.p. and 15 h.p., suitable for low-grade fuels and made by the Hamworthy Engineering Company, Limited, at their works in Poole, Dorset, are described in a special catalogue to hand from this firm. The engines are adapted for fixed or portable use, and examples are shown driving electric generators, pumps, air compressors and saws, which are also made by the company. They are manufactured on a large scale, so that very considerable quantities can be supplied.

Radiation Pyrometer.—Recent improvements in the fixed focus radiation pyrometer are described in a catalogue issued by the Foster Instrument Company, Letchworth. A ventilated receiving tube, or self-contained sighting device for long ranges or small hot bodies, and a housing for permanently fixing a tube to a furnace are amongst the special developments described. The catalogue also gives full information as to the working of the instrument in a form that will be easily intelligible even to those who are quite unfamiliar with it.

Cultivating Machinery.—A particularly complete and interesting catalogue which has reached us from Messrs. John Fowler and Co. (Leeds), Limited, deals with the engines and implements necessary for what is probably the most economical method of land cultivation on a large scale. Both the method of operation and the machinery employed is distinctly British, having been introduced by the late Mr. John Fowler seventy years ago, and continuously and progressively developed since then by his firm. The system provides for rapid and thorough ploughing, and the lighter machining operations on the soil are then easily effected by the same means. Strips of land, usually from 400 yards to 600 yards wide, and of any length, are worked with two cable engines which pull the plough or other machine from side to side, the ploughman travelling with the machine to control the operations. Ploughs having a large number of shares are used for surface work, while for subsoil ploughing a smaller number of shares are employed. For cultivation on a smaller scale a single engine with an automatically-travelling anchor may be used. The engines are also suitable for road haulage work and for driving machinery. The machinery is largely exported to all parts of the world, and it is hardly necessary to add that it must be of the highest quality to ensure reliability.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in Italics.

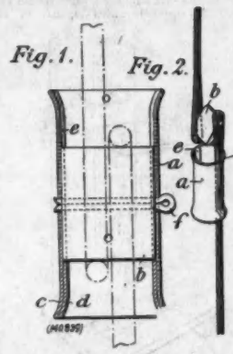
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

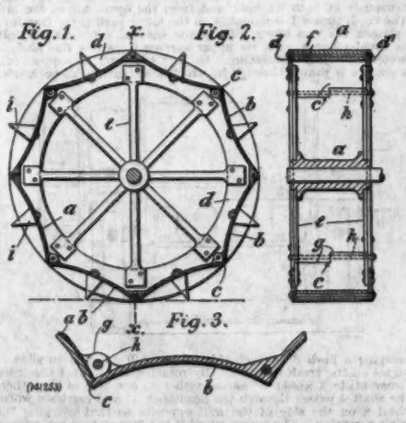
140,839. F. C. Mears, Edinburgh. Release Device for Ropes. (4 *Figs.*) October 26, 1918.—The invention relates to a device for coupling together two ropes in such a manner that they may be quickly released, the improved device being especially designed for use by parachutists to enable them, upon reaching the ground, to quickly disengage themselves from the parachute. The device consists primarily of a sleeve and a block arranged within it, designed to pass through loops on the ropes and hold them in position side by side until such time as the sleeve is slid off the block, when the ropes pulling in opposite directions will rotate the block and, consequently, be instantaneously released with absolute certainty. *a* indicates the sleeve and *b* the block arranged within it, and to which loops or eyes on the ropes are



connected. Guides for the block are formed inside the sleeve to ensure the proper positioning of the said block. The sleeve is constructed of two tubes *c*, *d*, fitted one within the other and slightly expanded at the two ends to hold them together, the inner tube *d*, before being inserted, having guide slots *e*, *e*, cut through it. In using the device the block *b* is first passed through the loops or eyes on the ropes and the sleeve is then slipped over the block to prevent the ropes from slipping off the latter. When the ropes are to be released it is only necessary to slide the sleeve off the block, so that the ends of the latter are uncovered, thereby allowing one or both ropes to slip off. A split pin *f* is passed through the block and sleeve, and is withdrawn, when the device is to be operated. (*Accepted April* 14, 1920.)

AGRICULTURAL APPLIANCES.

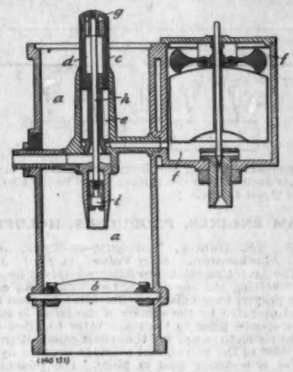
141,253. T. G. Richmond, Meigle. Agricultural Tractors. (3 *Figs.*) July 5, 1919.—The invention relates to the wheels of agricultural tractors and each wheel, instead of having a plain circular rim, has a rim of polyhedral formation with its series of faces either flat or slightly concave, and bounded at each side by circular rims so arranged that, when the wheel is on a road it runs on the circular rims whereas, when on the land, it runs on its slightly concave faces. The wheel has an octagonal



rim *a* with concave faces *b* and apices *c*, the rim being made in sections, the sections being secured to two circular side rings or flanges *d*, *d*1, held in place by spokes *e*. The sections of the wheel are bolted by bolts *f* to the rings *d*, *d*1, and secured together by interlocking lugs *g* and bolts *h*. Pointed or other spuds *i* are secured to the rim *a*. When the wheel is to run on the road the spuds are removed so that the wheel may run easily on the flanges *d*, *d*1. (*Accepted April* 21, 1920.)

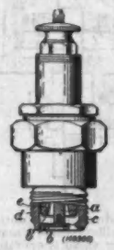
GAS ENGINES, PRODUCERS, HOLDERS, &c.

140,151. C. J. Grace, Truro. Internal-Combustion Engines. (1 *Fig.*) January 15, 1919.—The invention relates to means for supplying fuel to internal-combustion engines and relates more especially to that type of apparatus in which the orifice of the fuel jet is opposed by a baffle capable of adjustment. According to the invention, the baffle is connected to the throttle or throttle lever in such a manner that as the throttle is closed the baffle is moved into closer proximity to the fuel orifices so as to damp the velocity of the fuel issuing through the jet and *vice versa*. *a* is the induction pipe provided with a throttle



valve *b*; between this valve and the cylinder are mounted two tubes *c* and *d* with grooves between them. The two tubes are fixed in a chamber *e* to which liquid fuel is supplied from a constant level chamber *f*. To the upper end of the rod *h* is secured a baffle *g* having its surface in opposition to the jet, whilst to the lower end of the rod *h* is secured a lug *i* connected to the throttle valve *b* by link work in such a manner that as the throttle is closed the baffle *g* is brought into closer proximity to the jet so as to damp the velocity of the fuel issuing from the jet and *vice versa*. (*Sealed.*)

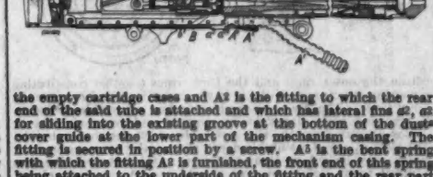
140,900. H. Terry and Sons, Limited, Redditch, and A. V. Terry, Redditch. Sparking Plugs. (2 *Figs.*) March 25, 1919.—The invention relates to sparking plugs for internal combustion engines, and has relation to plugs of the class in which a plurality of spark gaps are furnished between radial projections on the central or positive electrode and an annular sparking element constituting the negative electrode. According to the invention, a sparking plug of this type has a spark gap of a different width or size between each of the projections on the central electrode and the sparking element appertaining to the plug casing. The central electrode *a* is fitted with a nickel or other three-armed member *b*, the arms of which are



of differing radial lengths. A nickel ring *e* is secured within the lower extremity of the screwed base *d* of the shell, between which and the arms *b* appertaining to the central electrode *a* three gaps *c* of varying widths are provided. The radial arms *b* of the central electrode *a* have their extremities or points overturned as at *b*1. The central electrode *a* may eccentrically be adjusted in relation to the annular sparking member *c* appertaining to the shell. The annular character of the sparking element *c* permits of the entire internal circumferential surface thereof being used for sparking by periodically rotatably adjusting the central electrode *a* in relation to the shell. The central electrode is carried by an insulator secured within the shell. (*Accepted April* 14, 1920.)

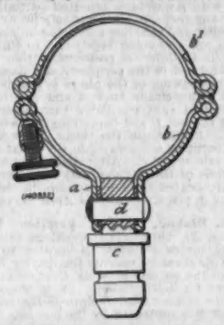
GUNS AND EXPLOSIVES.

141,108. Sir A. T. Dawson, Westminster, and Sir G. T. Buckham, Westminster. Machine Guns. (5 *Figs.*) January 2, 1919.—The invention relates to machine guns, particularly those provided with an injection tube for the discharge of the empty cartridge cases which tube may be furnished with a bent spring for retaining the empty cartridge case that has been forced into the ejection tube. According to the invention, the ejection tube is adapted to be slidably connected in a readily detachable manner to the mechanism casing of the gun. A is the mechanism casing of the gun, A1 is the ejection tube for



the empty cartridge cases and A2 is the fitting to which the rear end of the said tube is attached and which has lateral fins *a*2, *a*2 for sliding into the existing groove at the bottom of the dust-cover guide at the lower part of the mechanism casing. The fitting is secured in position by a screw. A3 is the bent spring with which the fitting A2 is furnished, the front end of this spring being attached to the underside of the fitting and the rear part projecting through a gap in the lower part of the fitting to protrude into the hole in the fitting through which the empty cartridge cases pass. The rear end of the spring fits under a part *a*3 *c* of the fitting, which part limits the upward movement of the spring. B is the spring plunger provided in the lower part of the extractor B1, this plunger having a small nose portion *b* against which the lower edge of the cartridge rim bears. The plunger and its spring are retained in position by a screw-threaded plug *b*1, which can be readily removed to enable the plunger or the spring to be replaced by another. (*Accepted April* 21, 1920.)

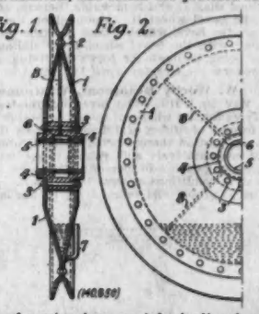
140,833. R. Allen, Caversham. Machine-Gun Mountings. (2 *Figs.*) October 6, 1917.—The invention relates to gun-mounting yokes of the kind comprising a circular part arranged to embrace the gun and composed of three pillar segments, two of which are pivotally connected with a pillar for fitting into a socket on the gun mounting while the other segment is hinged to enable a yoke to be opened or closed and secured in the closed position by a shackle and screw fastening. The invention includes a positive connection between the pillar segments and the pivot bolt by which they are attached to the pillar, and a screw-thread connection between the pillar and the socket of the gun mounting in which it is inserted. The extended ends *a*, *a*, of the pillar segments *b*, *b*, which receive between them the head



of the pillar *c*, are positively connected to the pivot bolt *d* and thereby compelled to move in unison by forming a flat on the bolt and corresponding locking flats in the bolt holes of the pillar segments. If the holes are broached with their flats in their proper relative position, when the hinged member *b*1 of the yoke is released and thrown back to enable a gun to be placed in position, the segments *b*, *b*, must move in unison if they be moved at all to facilitate the insertion of the gun, thus enabling the gun to be rapidly and accurately positioned in the yoke and secured. In lieu of forming the flats, a positive connection may be made by pressing the head of the bolt and the nut into locking recesses formed in the moving members after being bolted up, the members being mounted on a dummy gun barrel or plug prior to the bolt being locked into position, or keys may be secured in the same manner. (*Accepted April* 14, 1920.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

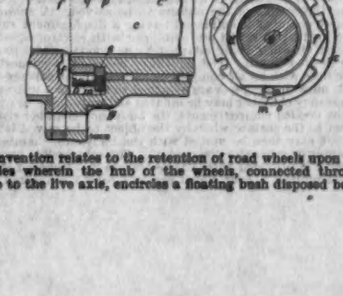
140,850. Stothert and Pitt, Limited, Bath, and E. W. Lawrence, Bath. Self-Oiling Pulleys. (5 *Figs.*) November 28, 1918.—The invention relates to improvements in self-oiling pulleys having an oil reservoir and provided with means for supplying oil to the pulley bearing. According to the invention, a pulley is constructed of pressed metal plates which are riveted or welded together and secured to a central hub, thus forming an oil reservoir, and means are provided for supplying



oil consisting of a wire, tape, or tube leading from the outer periphery of the pulley and passing through holes in the pulley hub to supply oil to an annular space in it. 1 are pressed metal plates forming the pulley and riveted together near their periphery at 2. The plates 1 are riveted at 3 to a central hub 4. The hub 4 is provided with a bush 5, and has an annular space 6. 7 is a tube for introducing oil into the pulley 1; the oil is supplied to the annular space 6 by means of twisted metallic tapes 8, passing through the hub 4, and passes from the annular space 6 to the bearing through holes 10 in the bush 5. (*Accepted April* 14, 1920.)

MOTOR ROAD VEHICLES.

140,879. J. I. Thornycroft and Co., Limited, Westminster, London, and T. Thornycroft, Westminster, London. Road Wheels. (3 *Figs.*) February 15, 1919.—



The invention relates to the retention of road wheels upon motor vehicles wherein the hub of the wheels, connected through a flange to the live axle, encircles a floating bush disposed between

said nut and the axle sleeve. In cases where a hardened steel thrust collar and nut are employed to retain the road wheel in position upon the axle sleeve, it is essential to reliability that the collar should be capable of minute adjustment in order to eliminate slackness as far as possible and thus reduce wear. This is achieved by arranging that the thrust collar shall be movable axially upon the axle sleeve but without rotating thereon and utilising such collar as one member of nut-locking means in which the nut has a plurality of locking regions differing in number to a plurality of locking regions in a companion member, there being combined with such nut and companion member a device adapted to temporarily hold the nut and companion member together at any pair of regions for the time being in register, the arrangement being a differential one affording a number of locking positions in excess of that obtainable had the locking regions in the nut and companion member been equal. *a* indicates the flange which connects the hub *b* of the wheel to the live axle *a*; *d* indicates the floating bush between the wheel hub *b* and the axle sleeve a^1; *e* the hardened steel thrust collar, and *f* the nut screwed on the axle sleeve a^1 for holding the collar *e* in place endways. The thrust collar *e* is formed with seven holes *g* and the nut *f* with six slots *h*, repeated partial rotation of the hub *b* bringing any one slot *h* successively into register with the holes *g* in the collar and enabling a pin *m* to be placed in any such hole to key the nut and collar together. In this way the nut *f* can be locked in 42 different positions, within one revolution. The slots *h* are formed in the periphery of a flange *n* on the nut. Unintentional unscrewing of the pin *m* is prevented by forming it with a hole diametrically thereof and passing a split pin *o* through it, the said split pin being such as to make contact with the flat of the nut *f*, and being removed when the pin *m* is to be removed. Rotation of the thrust collar is prevented by a key *p* which occupies a keyway *q* in the collar and also a keyway q^1 in the axle sleeve *d*. After fitting the key in place the edges of the walls of the keyway may be hammered over and the whole finally heated by a blow-lamp, in this way securely sweating the key in place. (*Accepted April* 14, 1920.)

140,945. R. Blakoe, London. Friction Driving Gear. (3 *Figs.*) June 20, 1919.—The invention relates to friction driving gear for motor vehicles. According to the invention, slow speeds are obtained by moving the driving disc from centre of driven disc to the outside of same, thus obtaining the fullest possible leverage for hill climbing. A is the shaft from the engine driving the splined shaft B through the universal joint B. The splined shaft E is supported by the bearings C, C. Mounted

Fig. 1.

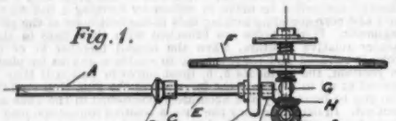
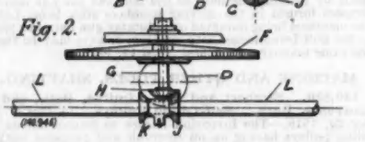
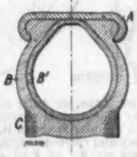


Fig. 2.



on the shaft E, and movable on it between the bearings C, C, is the driving disc D which drives the large horizontal driven disc F by friction on its lower face. The disc F is mounted on the vertical splined shaft G and is movable thereon, and fixed to the shaft G is the bevel wheel H. Mounted on the rear axle and fixed to it are the bevel wheels J and K, either of which can be made to mesh with the bevel wheel H by sliding them on the axle L, one being in mesh for forward driving and the other, say K, for reverse. (*Accepted April* 14, 1920.)

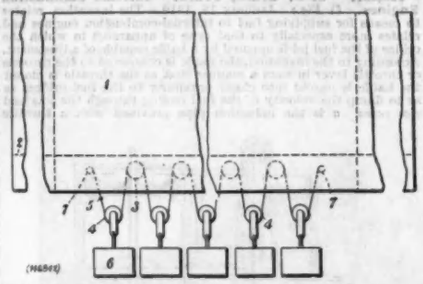
141,216. W. Worby Beaumont, Westminster. Tyres. (2 *Figs.*) May 20, 1919.—The invention relates to solid and pneumatic tyres for the wheels of motor and other road vehicles. The tyre is formed of rubber of different degrees of hardness, the central or main portion thereof being of hard rubber, whilst the edges are of comparatively soft rubber; the latter extending some distance along each side thereof, with a view to maintaining the same relative conditions as wear takes place. A is the wheel rim, B the usual rubber and fabric tyre, B^1 the inner tube, and



C, C, the parts composed of the tough, softer and more flexible rubber, formed integral with the main body of the tyre. With a rubber tyre constituted in this manner, the greater portion of the tread is composed of material best suited to load-carrying, without either the tendency to wear by detrusion or excessive kneading as the wheel rolls, or the tendency to wear by abrasion; whilst the edges of the tyre are of a softer, tougher or more flexible nature, adapted to maintain close contact with the surface of the road, owing to their readiness to yield under the pressure to which they are subjected. (*Accepted April* 21, 1920.)

SHIPS AND NAUTICAL APPLIANCES.

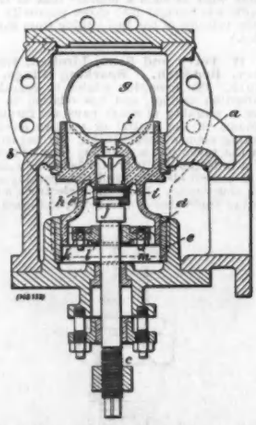
140,842. J. Neale, Oxshott, Salvage. (2 *Figs.*) November 27, 1918.—The invention relates to appliances for use in salving sunken vessels or other ferrous objects and employing electromagnets adapted, when energised and in contact with the object to be raised, to attach themselves to such objects and to take the weight of the objects to be salved. A submersible buoyancy chamber is employed having a displacement sufficient for the load to be raised and equipped with electromagnets, the buoyancy chamber being adapted to be flooded and submerged to the desired depth. The buoyancy chamber is connected by flexible hose with an air compressor carried by the salvage vessel, so that, once the magnets are attached to the object to be raised, the buoyancy chamber may be inflated and water may be expelled from the flooded compartments, the buoyancy chamber rising by flotation to the surface whereby the object to be salved is raised so that it may then be moved with the buoyancy chamber into shoal water or otherwise disposed of. The submersible buoyancy chamber 1 is provided with a false bottom 2. Mounted thereon are fixed pulleys 3, over which passes a rope 5 connected at its ends at 7 with the buoyancy chamber and in loops in which are supported running pulleys 4 from which are suspended the electromagnets 6. A flexible hose having branches is connected



to the compartments of the buoyancy chamber and electrical conductors are led from the surface vessel to the electromagnets. (*Accepted April* 14, 1920.)

STEAM ENGINES, PRODUCERS, HOLDERS, &c.

140,159. S. Hunter, Newcastle-on-Tyne, and J. S. Mackay, Monkseaton. Stop Valve. (1 *Fig.*) January 30, 1919.—The invention relates to balanced valves for the control of fluid involving the use of a piston forming an extension of the valve proper, an auxiliary or pilot valve disposed in the main valve and operated by the spindle of the latter in such manner that it is opened prior to the main valve to allow any steam behind the piston to escape and thus effect equalisation of pressure on both sides of the valves, and a bridge member by which the pilot valve is normally held in place. The present invention consists in construction of such a valve whereby the pilot valve may be more readily fitted in and withdrawn from the main valve than hitherto. *a* designates the body of the valve, *b* the main valve operated by the spindle *c* and provided with an extension forming the piston *d*, the latter working in a cylinder *e* formed by an annular projection on the valve cover. The main valve *b* is provided with a passage *f* to provide communication between



the underside of the piston and the outlet *g* to the engine, said passage housing the auxiliary valve *h* seated on the main valve *b* at *i*. The said auxiliary valve is operated by the spindle *c*, the head of the latter engaging as at i^1 with the head of the valve. For the purpose of opening the main valve, the spindle is provided with a collar *j* to co-act with the bridge *k* inside the piston *d* at that end remote from the main valve, there being a certain amount of clearance provided between the parts *j* and *k* when the valves are in the closed position. To enable the auxiliary valve *h* to be readily fitted and withdrawn, the bridge *k* is detachable and connected to the piston *d* as by means of studs *m* securing a detachable portion *l* to an annular flange on the interior of the piston, the opening in the flange being sufficiently large to enable the auxiliary valve with spindle *c* to pass therethrough for fitting to or withdrawal from the main valve *b*. (*Sealed.*)

141,191. Swan, Hunter and Wigham Richardson, Limited, Newcastle-on-Tyne, and F. Rowntree, Newcastle-on-Tyne. Piston Rings. (6 *Figs.*) April 10, 1919.—The invention relates to piston rings of the kind in which the piston ring unit comprises two outer rings expanded by an inner ring. According to the invention, a piston ring unit has the inner and outer rings so constructed and arranged that the several rings are prevented from turning relatively to each other. For this purpose the inner expansible ring is provided with slots adapted to receive stops which fit over the ring and each of the two outer rings has a portion cut away to also receive the stops, the inner ring fitting

Fig. 1.

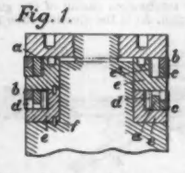
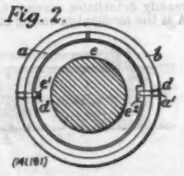


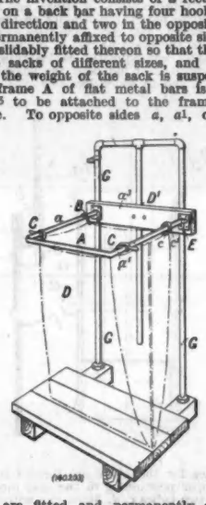
Fig. 2.



within the outer rings and the three rings together constituting a floating structure or unit. *a* is the inner ring and *b*, *c*, are the outer rings. The inner ring *a*, which is of an expansible character, is provided with diametrically opposed and reversed slots a^1 disposed away from the slit preferably at 90 deg. on each side. The slots a^1 are of a suitable depth and width to receive stops *d*, which may be cut or formed from a suitably-turned ring and adapted to fit tightly over or around the ring *a* when placed in the slots a^1. The outer rings *b* and *c* are turned on the outside diameter equal to the bore of the cylinder or liner, and on the inside to a diameter equal to that of the outside diameter of the ring *a* when in place in the cylinder or liner. An amount equal to the width of the stops *d* plus the required clearance, is cut out of the rings *b* and *c*, and after the three rings are assembled or fitted together they are placed in an annular groove formed in a distance-piece *e*, which is also formed with slots e^1, e^2, the slot e^1 being adapted to receive one of the stop pieces *d*, and the slot e^2 being slightly wider than the stop pieces or of sufficient width to allow the rings to open out in their effort to expand. The depth of the space e^3 in the distance-piece into which the rings are fitted is such as to allow the rings to float. There are two distance pieces *e*, one for each ring unit and said distance pieces are prevented from turning by means of pins *f*. The inner ring *a* is also prevented from turning by the slots a^1, e^2, whilst the stop-pieces *d* and the outer rings *b* and *c* are prevented from turning by the slots a^1 engaging the stop-pieces *d*. The split in the ring *b* will be arranged opposite to that in the ring *c* so that the latter ring will seal the split in the ring *b*, therefore the pressure in the cylinder cannot leak between the outer rings *b* and *c* and the cylinder wall. The rings *b* and *c* will also be arranged to seal the split in the lower ring *a*, and they will fit close on to the ring *a* so as to prevent pressure in the cylinder getting behind the rings which collectively are a floating fit in the space e^3. Only the outer rings *b* and *c* are subject to wear. (*Accepted April* 21, 1920.)

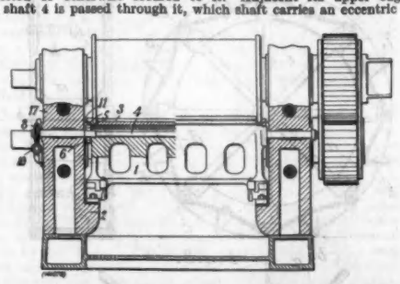
MISCELLANEOUS.

140,203. H. Wallworth, Macclesfield. Sack Holder. (5 *Figs.*) March 18, 1919.—The invention relates to a holder for holding sacks open at the mouth whilst being filled, of the type in which a frame is supported upon uprights and provided with relatively adjustable hooks or clips to engage and suspend the bag or sack. The invention consists of a rectangular frame of metal mounted on a back bar having four hooks fitted thereon, two facing one direction and two in the opposite direction, two of which are permanently affixed to opposite sides of the frame, and two hooks slidably fitted thereon so that their position may be adjusted to sacks of different sizes, and will retain that position when the weight of the sack is suspended therefrom. A rectangular frame A of flat metal bars is mounted on a traverse bar a^3 to be attached to the frame G of a potato sorting machine. To opposite sides *a*, a^1, of the frame A,



two hooks B are fitted and permanently affixed, and two hooks C slidably movable mounted thereon. The hooks B are set facing in opposite directions to the hooks C, so that when drawn apart they stretch the material of the sack D mounted thereon and hold it securely in position. The movable hooks C are so fitted as to lock or bind themselves upon the bar when the weight or tension of the sack pulls upon them. The hooks B have two or more points *c*, c^1, to accommodate sacks of different sizes. The movement of the movable hooks may be limited by pins inserted transversely into the bars. Fitments D1 are attached to the back bar to secure the holder in position on the machine. The frame A is pivoted or hinged to the back bar a^3 so that it may be turned up out of the way when not in use, and to it are fitted stops E to hold it in horizontal position. (*Sealed.*)

141,078. J. Miller, Derby, and G. Fletcher and Co., Limited, Derby. Crushing Mill. (2 *Figs.*) August 8, 1916.—The invention relates to sugar cane or like crushing mills and particularly to an improved means for the adjustment of the trash turner relatively to the rollers with which it co-operates. According to the invention, means are provided for adjusting the bar and thereby the trash turner blade carried by it, simultaneously at both its ends, and from the open side of the mill. The trash turner 1 is mounted on the lower part of the framing 2 between the two lower rolls in the case of a three-roller mill, in usual manner. On its upper surface it carries the blade 3, bolted or otherwise secured to it. Adjacent its upper edge a shaft 4 is passed through it, which shaft carries an eccentric 5



engaging a bush 6 on each side of the mill adapted to slide in guides on the trash turner 1. By rotating the shaft 4 the trash turner blade 3 would be moved either to one side of the other. The shaft 4 passes through the headstock 17 and carries a worm wheel 8 on the side of the mill opposite to that carrying the driving gearing. The worm wheel 8 is adapted to mesh with a worm 10 provided with a handle or with tommy holes whereby it may be rotated. Consequently, whenever the trash turner blade requires adjusting this may be effected by a turning of the worm 10 from the open side of the mill without necessitating the stoppage thereof. To protect the adjustment mechanism consisting of the eccentric bush 5 and block 6, a guard plate 11 is provided which shrouds this adjustment mechanism by directing the juice away from it. (*Accepted April* 21, 1920.)